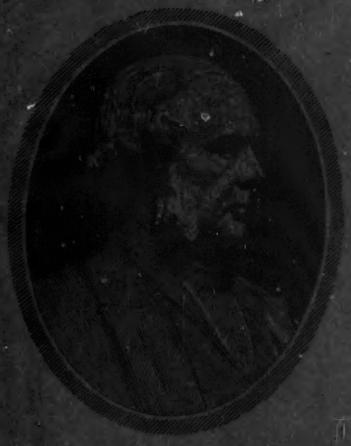
OL. XXXIV QUARTERLY No. 133

DICAL LIBRARY

The British Journal of Surgery



LISTER

JULY, 1946

BRISTOL: JOHN WRIGHT & SONS LTD.

LONDON: SIMPKIN MARSHALL (1941) LTD., 12, OLD BAILEY, E.C. 4

WHOLESALE DISTRIBUTORS: WM. DAWSON & SONS LTD.
43 WEYMOUTH STREET, LONDON, W.1.

UNITED STATES OF AMERICA: THE WILLIAMS & WILKINS COMPANY, BALTIMORE, *Sole Agents*

Entered as second class matter at the Post Office at BALTIMORE under the Act of March 3, 1879. (Sec. 225 P. L. & R.)

PENICILLIN

We take pleasure in announcing the introduction of the following range of Penicillin preparations for local, external and parenteral use :—

Penicillin (sodium salt) in vials containing 100,000 i.u.

Penicillin (sodium salt) in vials containing 200,000 i.u.

Penicillin (calcium salt) Lozenges 500 i.u., tubes of 20.

Sterile Penicillin Suspension (calcium salt) 125,000 i.u. per c.c., in 10 c.c. vials.

Sterile base for Penicillin Cream in jars of 25 grammes.

Apyrogen, Pyrogen-free Sterile Distilled Water, in 10 c.c. ampoules.

A twenty-four hour dispensing service is in operation at Allen & Hanburys Ltd., 7, Vere Street, London, W.1. for the supply of extemporaneous preparations of Penicillin.

ALLEN & HANBURYS LTD · LONDON · E.2

THE
BRITISH JOURNAL OF SURGERY

VOL. XXXIV JULY, 1946 No. 133

THE HAZARDS OF PARACHUTING

By P. ESSEX-LOPRESTI
SURGICAL SPECIALIST, 225 PARACHUTE FIELD AMBULANCE

THE many popular beliefs about the dangers of parachuting are gratifying to the men who parachute, but they are a poor compliment to the devoted band of men who have made it almost foolproof. Parachuting to-day, although one of the greatest thrills in life, is almost as safe as crossing a crowded street, and safer than playing Army football.

It is the purpose of this paper to examine the hazards of parachuting, employing the data provided by 20,000 jumps by men of the Sixth Airborne Division between January and November, 1944. All these descents were made by trained parachutists who had received their "wings" after completing their eight training jumps.

Until now the literature on parachuting injuries is mainly American and covers the training period only. Tobin et al. (1941) give the injury rate at the Parachute Training School, Fort Benning, in 1941 as 2·4 per cent, with a hospital admission rate of 0·7 per cent (25 per cent of injuries). The men were trained to land with feet apart, and 19 per cent of injuries were fractures, all but 3 of the 25 being of the lower limb. In June, 1943, the Americans adopted the British "feet and knees together" landing, and their casualty rate from all training causes fell from approximately 9 per cent to 3·5 per cent: the parachuting injury rate is not stated (Lord and Coutts, 1944). These figures include those whose injury caused the man to lose one day or more from duty, and for this reason the figures are not comparable with ours.

During training every man is taught the safety precautions which are taken on his behalf and the rules he must observe to ensure his own safe descent. It is astonishing how careless the parachutist becomes after he leaves the parachute school: perhaps it is due to his confidence in his equipment, but there is no doubt that the majority of injuries are his own fault and could have been prevented.

THE STATICHUTE

Before the various causes of injury during descent can be appreciated it is necessary to understand the statichute and its mechanism. 86 sq. yd. of silk or nylon, forming a canopy 28 ft. in diameter, and 28 rigging lines attached to the harness are packed in a bag on the man's back (*Figs.* 1, 2). The bag is attached to the plane via a strong webbing belt, the static line. During the initial free drop following the jump the static line is pulled out to allow the parachutist to get clear of the plane and slipstream. His further fall pulls out first the rigging lines and then the canopy from the bag, which is ultimately left trailing behind the plane. As the canopy fills with air (i.e., develops) the free fall of the parachutist is slowed and he floats to earth at approximately 14 ft. per second. During the descent air has to escape from the canopy, and a vent, 22 in. in diameter, is provided at the top, which prevents the air spilling out under the periphery, first one side and then the other, and thereby causing the man to oscillate. Oscillation is dangerous, because the ground may be reached at any stage in the swing, and control of the landing position of the body therefore impossible (*Fig.* 3). The rigging lines are attached at their lower ends to a comfortable webbing harness which is designed to be removed quickly on landing to prevent the parachutist being dragged in a wind and to enable him to be ready at once to deal with any other dangers which may confront him in enemy territory.

FIGS. 1, 2.—The statichute and harness. Note the static line in the parachutist's left hand. (*New York Times.*)

THE DESCENT

Injuries occur during three phases of the descent, and the following description will lay special emphasis on the dangers of each stage. The three phases are: (1) The exit from the plane; (2) The development of the parachute; (3) The landing.

1. The Hazards of the Exit.—There are two routes of exit for the parachutist, depending on the type of plane in use: (*a*) The door exit from the side of the fuselage; and (*b*) The hole in the floor, the size of which varies with the particular aircraft.

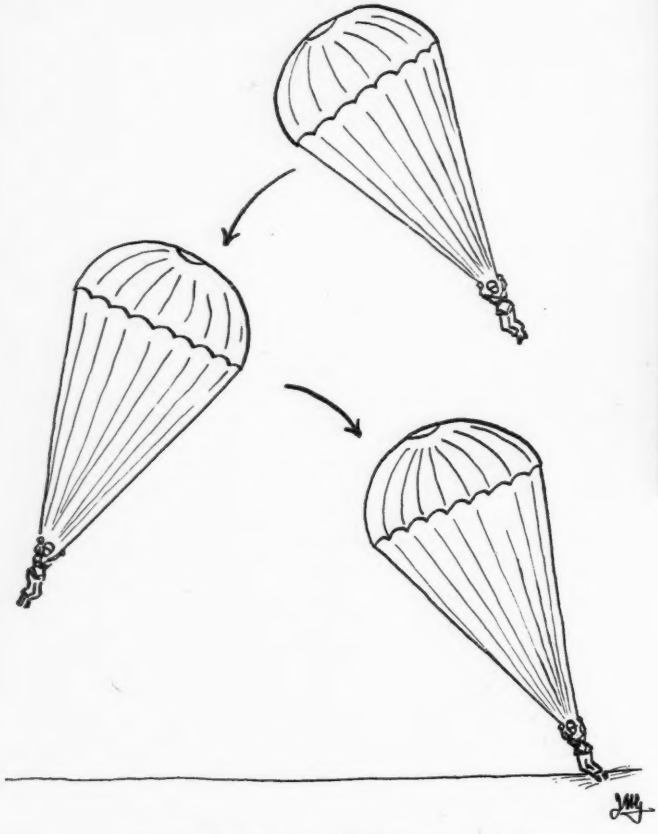


FIG. 3.—Oscillation. Landing on the swing.

FIG. 4.—Ready to jump from a Dakota. Note the static line of No. 1. (*Picture Post.*)

a. The Door Exit.—The leading man stands in the door with his static line passing to the runner or 'strong point' on the opposite side of the plane, and the remainder of the 'stick' are lined up behind him (*Fig.* 4). Each man guides the attachment of his static line along the runner as he moves back to the door and then, dropping it behind him, turns and jumps out as close behind his predecessor as he can. If the static line is not held correctly in the left hand it is possible for it to slide up in front of the left arm on its way from the parachute pack to the runner. In this case, as the man jumps, the line flings his arm into extreme abduction and external rotation and usually dislocates the shoulder-joint, or causes a severe sprain with bruising of the upper arm (*Fig.* 5).

It will be obvious that, as the man drops, his static line will whip down the rear lintel of the door to the lower corner, but sometimes as it goes it will

FIG. 5.—Door-jump with the static line caught in front of the arm.

flick like a snake, and the wise parachutist will watch for this out of the corner of his eye as he follows and avoid tripping over it. If he does trip he may somersault.

b. The Floor Exit.—With the small aperture the exit is made seated, the hands being used to push off from the edge while the body is thrown into a position of rigid " attention " with the neck braced back. Successive jumpers swing into the aperture and push off as quickly as possible (*Fig.* 6). The main risk is due to failure to hyperextend the neck, so that the body tilts forward and the chin, nose, or forehead strikes the opposite side of the aperture (*Fig.* 7). At the training school this mishap is called " ringing the bell " and costs its victim a round of drinks. Once again the weaving static line of one's predecessor must be watched as the swing into the hole is made, especially by men jumping from aft.

The larger apertures enable the men to approach stooping or crouching and to jump out as they reach the edge (*Figs.* 8–10).

2. The Hazards of Parachute Development.—The rigging lines are pulled out in two bands rising from the shoulders of the harness. The steady opening of the canopy is felt by the jumper as a smooth and powerful pull, and all at once he finds himself swinging gently, apparently stationary above the country side (*Figs.* 11–14).

Most of the accidents in this stage are the result of a faulty exit from the plane, which has caused the man to somersault or twist. Somersaulting brings no particular added danger provided a good

FIG. 6.—A good jump position going through the small aperture. (*Picture Post.*)

jump position is maintained, with legs together and arms well tucked in, for the somersault is then made clear of the rigging lines. But in the slip-stream this is easier said than done, for the rush of wind seems determined to force the legs apart, and many a man has found himself swinging gently with one foot caught in the rigging lines and the countryside apparently above him. There is always time during the descent to disentangle oneself, and it is seldom that a landing is made upside down.

FIG. 7.—" Ringing the bell."

Lord and Coutts (1944) report a case of tear of the perineum from a rigging line which passed between the man's legs as he somersaulted. With the American 'chute the canopy opens first and the free fall of the parachutist is arrested with a jerk, and this injury has not been seen from similar accidents over here.

In the course of these aerobatics a sharp flick from the silk rigging lines can produce a burn of the face, arm, or leg.

Twists in the rigging lines are only dangerous in so far as they cause the parachutist to concentrate on kicking himself out of them: he fails to watch the ground and looks like a starfish as he lands.

3. The Hazards of Landing.—During training a man loses all anxiety in the exhilaration following the opening of his 'chute, and the landing is a minor, inevitable incident after the awe-inspiring leap. But it is on landing that most injuries occur, and the experienced jumper has discovered that his 'chute always opens, and hence the euphoria accompanying the glorious sense of isolation while floating down is tempered by an anticipation of the technical difficulties of meeting the ground. This, during the last 50 ft., rushes up at an ever-increasing speed, and apparently at an angle because of horizontal drift. Quick thinking and determined effort are necessary to make a correct and safe landing. The landing position of the body is relaxed, with

> Head well forward, shoulders round,
> Elbows in, and watch the ground. (*Fig.* 15.)

And the English training leitmotiv—" feet and knees together "—is more difficult than it sounds,

FIG. 8.—Watching for the green light over the large aperture. (*Picture Post.*)

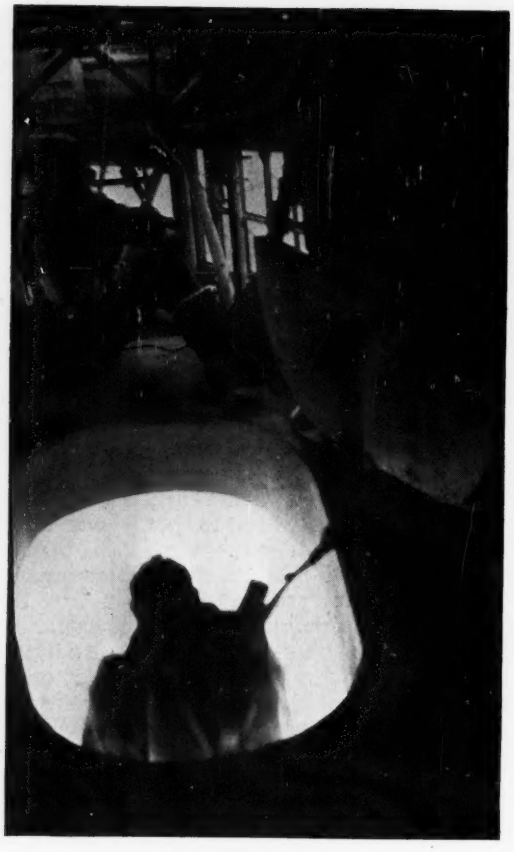


Fig. 10.

Fig. 9.

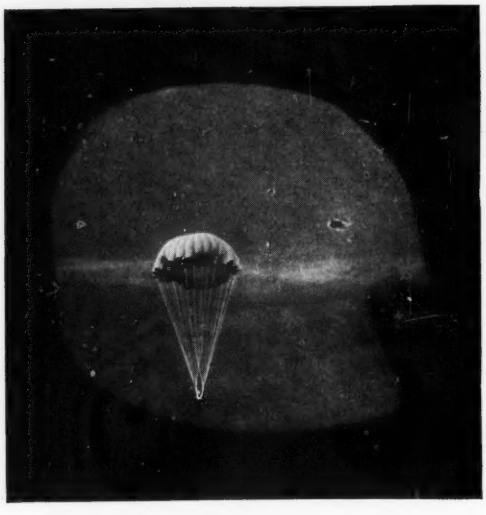


Fig. 11.

FIGS. 9–11.—The 'bunny hop' exit with the medium floor aperture. (*Air Ministry photos.*)

for the instinctive but dangerous reaction is to spread the legs and throw out an arm to 'save' oneself (*Figs.* 16, 17).

The correct landing procedure is to take the initial strain on both legs mutually splinted with the toes pointing across the line of drift, and to allow oneself to roll successively on to the outer side of the leg, thigh, buttocks, and opposite shoulder. It does not matter whether a man is drifting backwards or sideways, this method can be adapted to give him a safe landing, but he must avoid doing a pitch-forward landing, meeting the ground successively with toes, knees, elbow, and face: twisting slightly in the harness will prevent this.

Among the other hazards of landing are:—

a. Oscillation.—The importance of preventing this to enable a man to adjust his landing technique to the circumstances will now be appreciated, and

FIG. 12.—Development of the statichute. Canopy is still within the bag between the static line and the rigging lines. (*Picture Post.*)

FIG. 13.—Development of the statichute. Canopy clear but not yet filled with air. (*Picture Post.*)

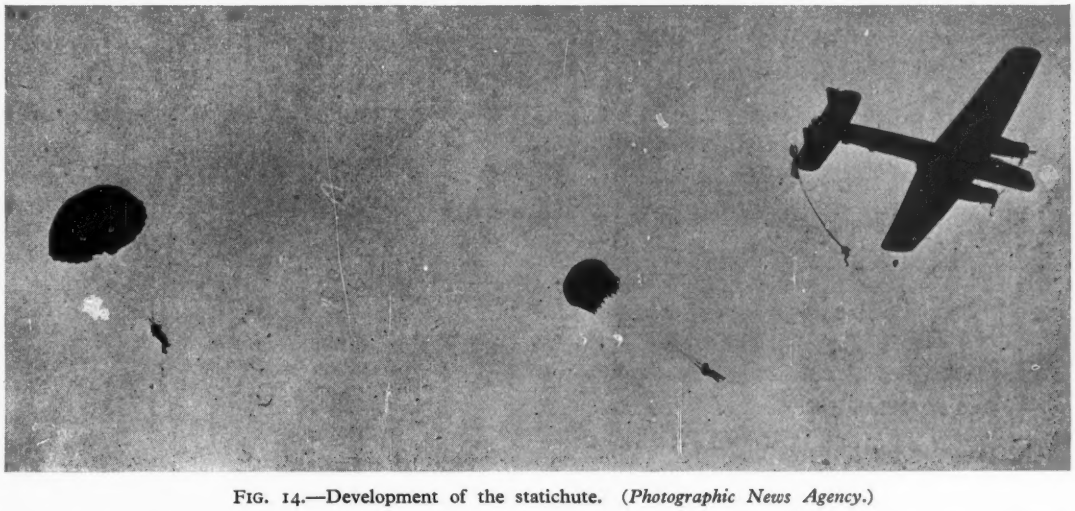


FIG. 14.—Development of the statichute. (*Photographic News Agency.*)

much research has been devoted to this subject. It occurs especially in gusty weather and is prevented by pulling down on half the rigging lines, which collapses a small segment of the periphery of the canopy and causes all the air to spill out on one side only.

b. Nature of the Ground.—This should be firm but not hard: grassland or ploughland is suitable. A tree landing is more comfortable than would be supposed (*Hygeia*, 1942), and the main hazard seems to be falling out of the tree while climbing down, often as a result of misjudging the height.

c. The Wind-speed.—Up to 20 m.p.h. is reasonably safe, though gusting even below that speed may precipitate a near-ground oscillation.

d. Weight and Height of the Individual.—Ungainliness and awkwardness are individual characteristics which may produce accident-prone jumpers. Most of these individuals are weeded out at the training school The least accident-prone jumpers are the short, stocky types, popularly known as "gnome-oid."

THE KITBAG

Heavy and bulky equipment is now carried in a bag attached to the leg by a quick-release device. When the parachutist is airborne he releases the bag from his leg and pays it out until it hangs below him by a 20-ft. rope. This method of carrying kit has many advantages. Each man on landing has

his own equipment near him at the end of a rope (the advantage of this at night is obvious), the weight of the bag (up to 80–90 lb.) steadies him in descent and helps to prevent oscillation. The kitbag reaches the ground about one second ahead of the man, and the sudden reduction of one-third of the

FIG. 15.—A good parachuting position. (*New York Times.*)

parachute's load causes it to "breathe," and most men state that their landings are much less heavy.

The kitbag has, however, its snags. It is clumsy and awkward in the aircraft, and it increases the overall time needed by a stick to leave the plane, which means that they are more spread out on the ground. It is one more gadget for the man to worry about, and released suddenly it may break away from its upper attachment to the harness and hurt somebody below—the shower of 80-lb. kitbags during a big exercise is quite terrifying to those already on the ground.

THE COLLECTION OF CLINICAL AND STATISTICAL DATA

The safety regulations for practice descents demand the presence of a safety officer, with velometer, and a medical officer and ambulance on the

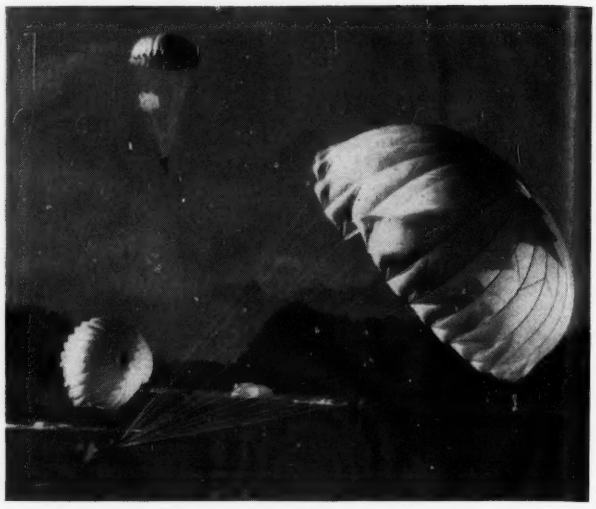


FIG. 16.—Landing: a stage in the roll. The man behind will make a bad 'ballet-dance' landing. (*Keystone.*)

dropping zone whenever parachutists are dropped. The medical officer is responsible for the treatment of casualties and for recording the following details of the exercise: the wind-speed, visibility, type of aircraft, number of parachutists dropped, and a list of the casualties with their age, weight, diagnosis,

FIG. 17.—Spreading the legs on landing.

and disposal. He is also asked to classify the casualties into those which, in his opinion, would or would not be able to carry on in a fighting capacity.

This method of collecting data allows a certain number of fallacies in interpretation and inaccuracies to appear in the figures, and it will be as well to examine these first:—

1. The total number of parachute descents was in fact greater than that recorded because returns of drops with no casualties were not always made. The number is unlikely to exceed 200–300 and would have the effect of reducing the casualty rates.

2. Some minor casualties " slipped the net " and were not recorded on the field. I have traced 61 of these and they are included except in the graphs.

3. The ability to carry on fighting was a personal estimate made immediately after the drop by a number of different doctors. These were all parachutists themselves and knew what degree of fitness was required, and subsequent battle experience has convinced me that their assessment was accurate.

4. Precise diagnosis was not always possible on the field and was usually made later as the acute condition began to settle down. The table of injuries (*Table I*) tends to be regional, and the details are discussed in the clinical section of the paper.

GENERAL STATISTICS

1. The overall casualty-rate for 20,777 descents was 2·1 per cent (437 casualties), of which only 0·5 per cent were sufficiently seriously incapacitated to prevent them from carrying on fighting (24 per cent of injuries) (*Tables II, III*).

Table I.—Classification of Injuries

Injury		No.	Percentage of Injuries	Percentage of Total Drops
Concussion		90	20·6	0·43
Strains		181	41·0	0·89
Ankle	71			
Knee	39			
Sup. tibio-fibular joint	7			
Shoulder region	28			
Erector spinæ	16			
Miscellaneous	20			
Dislocations		26	5·9	0·12
Shoulder-joint: Left	13			
Right	5			
Acromio-clavicular joint	8			
Fractures		37	8·5	0·18
Ankle	12			
Tibia and fibular shaft	8			
Metatarsals	3			
Skull/cervical spine	3			
Humerus	3			
Elbow region	2			
Lumbar spine and pelvis	2			
Clavicle	1			
Mandible	1			
Scaphoid	1			
2nd rib	1			
Fingers (cuts, bruises, rope burns, etc.)		15	3·4	0·07
Bruises		80	18·7	0·38
Miscellaneous		8	1·8	0·04
Total		437	99·9	2·11

2. Wind speed and type of drop (*Table II*). These figures had to be calculated on the incomplete total of casualties (376) and are therefore slightly low. It will be seen that wind speed above 15 m.p.h. increases the casualty rate rapidly (*Fig.* 18). From personal observation I have no doubt that gusting is the dangerous factor, by causing near-ground oscillation.

The fewest casualties occurred with balloon drops (1·1 per cent), probably because these drops were all made in good weather conditions: the maximum wind-speed was 12 m.p.h. in the series. Aircraft drops by day caused more casualties (1·9 per cent) than those by night (1·4 per cent). This is the reverse of what was expected, and is explained

Table II.—Casualty Rate by Type of Drop and Wind-speed

Type of Drop	Wind-speed in m.p.h. 0–5	6–10	11–15	16–20	Total	Percentage Casualty Rate
Balloon:						
No. of drops	298	61	451	—	810	1·1
Casualties	2	3	4	—	9	
Aircraft:						
Day No. of drops	4748	8593	4087	403	17,831	1·9
Day Casualties	82	152	83	20	337	
Night No. of drops	2060	56	20	—	2136	1·4
Night Casualties	23	7	—	—	30	
Total:						
No. of drops	7106	8710	4558	403	20,777	
Casualties	107	162	87	20	376	
Add 61 casualties found in Rehabilitation Centre					61	
Total casualties					437	
Percentage Casualty Rate	1·5	1·86	1·9	4·9		2·1

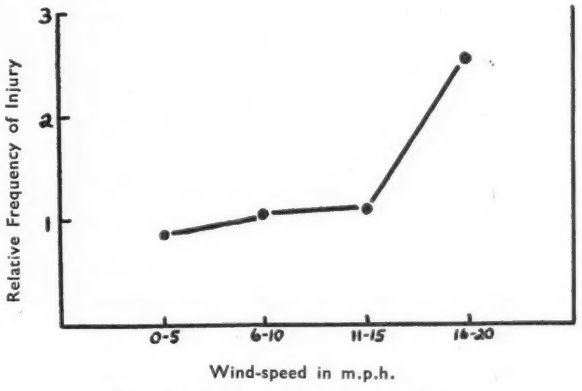


Fig. 18.—Effect of wind speed on injury rate.

Table III.—Severity of Injury

(Estimate made on Dropping Zone)

Assessment of of Injury*	No. Assessed	Proportion Adjusted to Actual No. of Cases	Percentage of Injuries	Percentage of Total Drops
A. Man could carry on	320	333	76	99·5
B. Man could not carry on	100	104	24	0·5
Total	420	437	100	100

* *A*, Injury not seriously preventing a man from carrying on in a fighting capacity. *B*, Injury incapacitating a man and preventing him from continuing to fight.

partly by the good weather conditions, and partly by the inability of the parachutist to see the ground: his landing position is not spoiled by a last-minute tensing.

3. Weight. The chart (*Fig.* 19) showing the relative frequency of weight in two battalions and the casualty rate in each weight demonstrates that more casualties occur in the heavier weights.

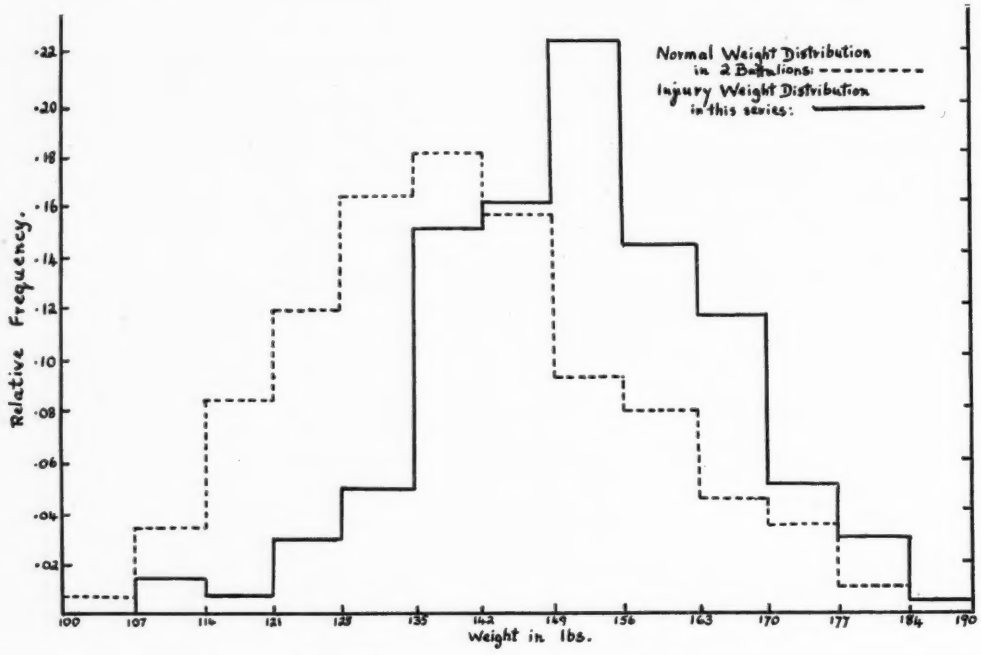


FIG. 19.—Effect of weight on injury rate.

Table IV.—CASUALTY RATES ON LARGE EXERCISES (OVER 1000 DESCENTS)

No. of Descents	Day/Night	Wind-speed in m.p.h.	No. of Casualties	No. of Type "B"	Percentage Casualty Rate	Percentage Incapacity Rate
1178	Day	15	20	9	1·7	0·77
1545	Day	0	25	9	1·6	0·58
4500	Day	8–11	42	7	0·93	0·15
1800	Night	0	18	7	1·0	0·38
9023			105	32	1·2	0·35

Table V.—INJURIES OCCURRING IN FIRST AIRBORNE DIVISION (APRIL, 1942, TO JANUARY, 1943)

	No. of Jumps	Contusions and Sprains	Fractures	Concussion	Fatal	Total
Aircraft jumps	9203	270 (2·9 per cent)	56 (0·6 per cent)	48 (0·5 per cent)	7 (0·08 per cent)	381 (4·1 per cent)
Balloon jumps	1493	25 (1·7 per cent)	7 (0·5 per cent)	4 (0·3 per cent)	—	36 (2·4 per cent)
Totals	10,696	295 (2·8 per cent)	63 (0·6 per cent)	52 (0·5 per cent)	7 (0·065 per cent)	417 (3·7 per cent)

DISTRIBUTION OF FRACTURES:—

Base of skull	1	Spine	7	Femur	1
Nose	6	Cervical	1	Patella	2
Clavicle	6	Dorsal	1	Tibia and fibula	1
Acromion	6	Lumbar	2	Ankle	20
Humerus	6	Coccyx	2	Potts	7
Scaphoid	1	Crush	1	Malleolus	3
Bennett's	1	Ribs	1	Not specified	10
		Pelvis	2		

4. Large exercise casualty rates (*Table IV*). These were all rehearsals for one or other of the Division's operations and the drops were followed by ground manœuvres. The casualties are fewer than the average, though it is in just these exercises that men tend to rush off without being spotted by the medical officers. The third day drop of 4500 was made as a rehearsal of the Rhine crossing, and the figures are surprisingly low in spite of the fact that on this occasion I was able to follow up and include all those who subsequently reported to the Rehabilitation Centre.

5. Concussion and sprains of all kinds account for 61·6 per cent of the injuries.

6. Fatalities. There were 4 deaths, of which only 1 was the result of the parachute failing to develop fully. The others were unfortunate accidents from unforeseen circumstances.

7. For comparative purposes it is interesting at this point to insert a brief report of injuries occurring in 10,696 drops by trained parachutists between April, 1942, and January, 1943, from a different formation (the First Airborne Division, of Arnhem fame) (*Table V*).

Casualties were not always so light. René de Gaulejac (1939) implied heavy casualties in the experiments in the French Army in 1939 and classified the injuries in four groups :—

1. Those where the parachutist became entangled with the plane or his 'chute failed to open and resulted in death.

2. Abdomino-thoracic injuries from the shock of the parachute opening.

3. Diverse organic lesions during the descent.

4. Various severe injuries of the lower extremities on landing.

CLASSIFICATION OF INJURIES

The following table relates the cause to the injury.

Table VI.—PARACHUTING INJURIES RELATED TO THEIR CAUSE

I. *The Injuries of the Exit* :—	
Dislocated L. shoulder Strains and Bruises, L. shoulder and arm	Static line held wrongly
Cut lip, facial injuries	Floor jump : 'Ringing the bell'
II. *The Injuries during Para-development* :	
Bruises, lacerations, and burns from rigging lines	Somersaults and twists
III. *The Injuries of Landing* :	
Concussion	Failure to keep head forward
Partial and complete dislocation, acromio-clavicular joint Fractured clavicle Dislocated shoulder	Shoulders not rounded
Strain supraspinatus and deltoid muscle	Elbows not tucked in
Strain, lateral ligaments of knee and ankle Fracture-dislocation of ankle Fracture, tibia and fibula	Separating feet and knees
Strain, superior tibio-fibular joint Strains and bruises of back	Badly executed roll
Fractured metatarsals Strain of foot Traumatic synovitis calcaneo-cuboid or cubo-metatarsal joints 2nd- and 3rd-degree fracture-dislocations of ankle	Feet not parallel to ground
IV. *Kitbag Injuries* :	
Fracture phalanges of hand Cuts and bruises of hands	Faulty grip or release of bag
Rope burns of hands	Loss of control in lowering
Bruises and strains of lower limbs and back	Landing with bag on leg

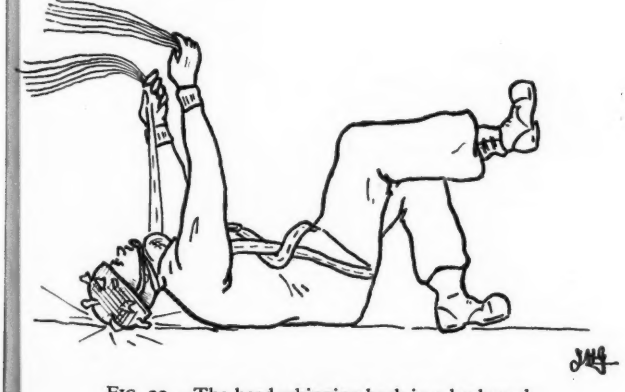


FIG. 20.—The head whipping back in a backward landing.

SOME CLINICAL ASPECTS OF PARACHUTING INJURIES

Concussion (90 Cases).—A common injury, the result of allowing the head to whip back during the roll, especially in a backward landing (*Fig.* 20). The period of unconsciousness varied from a few seconds to several days, and about 10 per cent of the cases had evidence of cerebral laceration. Treatment was on routine lines and the results satisfactory, provided the patient's activity was kept below headache threshold and made progressive within this limit. Reassurance and cheerful encouragement were valuable, but recurrent headaches were found to induce depression and a tendency for the man to report sick because he could not keep up with his fellows in the training programmes.

Strains (181 Cases).—

1. *Ankle* (71 Cases).—The vast majority of these were strains of the external collateral ligament. The tenderness was commonest and persisted longest in the anterior talofibular ligament. They varied greatly in severity, and in all cases both ankles were X-rayed with the foot held in strong inversion without anæsthesia. A small proportion of 'tilts' were observed, but none has required operation after rest and physiotherapy. Unfortunately, no follow-up has been done to determine whether healing of the ligament has occurred, but the two or three cases I saw returned to parachuting with no complaint. Most sprains with only a moderate degree of swelling were back to full airborne duties with painless ankles after 10–14 days' treatment. Novocain injection was very unsuccessful in my hands, but it was only used for the chronic cases. Lord and Coutts (1944) state that the length of disability is not shortened by procaine injection in acute cases. There does not seem to be any particular tendency for these cases to recur in subsequent jumps.

2. *Strain of Collateral Ligaments of Knee* (39 Cases).—This, too, was a fairly common injury. Some cases cleared up with treatment in 10–14 days. There was a larger proportion of knee ligament

strains which recurred, and which remained painful for a long time, than was found with the ankle, and traumatic synovitis was, of course, an invariable concomitant. Special attention was directed to the quadriceps muscle from the earliest moment. Recurrent traumatic synovitis with exercise occurred only in those cases where the muscle had been allowed to waste and upset the delicate muscular balance in the joint. In a few of these, stretching of the ligaments developed, and little could be done to restore them to airborne standards. In those cases in which pain persisted novocain injection was tried with little improvement—ionization was more successful, and it did not seem to matter which ion was employed.

There were three examples of torn internal cartilage, confirmed when the acute condition subsided.

One cases of rupture of the anterior cruciate ligament was seen in which weakness and letting down were present four months after the injury in spite of two month's immobilization; I lost sight of him after this because he was considered unfit for further parachuting and left the division.

3. *Strain of the Superior Tibio-fibular Joint* (7 cases).—This is an injury peculiar to parachuting, and is rather commoner than the figures suggest, because it is mild, does not always incapacitate the soldier, and is therefore often not reported. Lord and Coutts (1944) report a 'silent' fracture of the upper third of the fibula, and dislocation of the fibular head laterally ascribed to a similar mechanism, and occurring since the American change-over to the legs-together landing. The mechanism is the sideways strain on the leg during the first stage of the roll, or a sideways landing during an oscillation, which 'springs' the fibular head laterally (*see Fig.* 3). Some of my cases have reported that it was the result of a twist of the body after the feet were anchored. Immediately after the injury it is locally painful and tender and is often diagnosed as a minor sprain of the external collateral ligament of the knee. The following day there is usually little or no disability and examination reveals a swelling of the joint with local tenderness. It clears up rapidly and completely without special treatment.

4. *Strains of the Shoulder Region* (28 Cases).—Strain of the deltoid muscle and the supraspinatus tendon form about 50 per cent of this group. I have been expecting to see a complete tear of the supraspinatus tendon, produced by falling sideways on the actively abducting arm. The supraspinatus syndrome has been seen many times, with the characteristic arc of pain on passive movement and the localized tenderness, but all cases have cleared up completely with physiotherapy. It is possible that later some of these men will report with calcification in the tendon. One case of flake fracture of the greater tuberosity of the humerus without dislocation has occurred, and several examples of localized tenderness at or just above the deltoid insertion have been found. The mechanism is presumably similar to that producing supraspinatus strain.

The remainder of the cases in this group are strains of the pectoralis, coracobrachialis, biceps, latissimus dorsi, and teres muscles.

5. *Strain of Erector Spinæ* (16 Cases).—Ligamentous and muscular strains of the spine were not very common, but were always something of a problem in treatment. Some recovered quickly and completely with ordinary physiotherapy, but a high proportion complained of recurrent or persistent nagging pain. Ilio-lumbar and ilio-sacral ligament strains were the worst offenders. A few cases were referred to a centre which possessed diathermy and did well, and it is my view that diathermy from the outset would produce a greater proportion of cures. Recurrence was common and it is probable that most of these cases should not be allowed to parachute again.

One interesting case of back injury is worth special mention. A man was sent to the Rehabilitation Centre with acute pain in the lower part of his back following a jump in November, 1944. His history revealed that he had injured his back in a drop two years previously, and this had troubled him on and off ever since, but not sufficiently to prevent him carrying out full airborne training. Clinical examination showed that he had recurrent subluxation of the left sacro-iliac joint, and X-ray examination revealed osteo-arthritis in the joint, which suggested that he had had the condition since the original injury.

A second case of interest is that of an officer who injured his back in a drop in October, 1944, and was diagnosed and treated as a strain of the erector spinæ after negative X-ray examination. He was re-X-rayed three weeks later because of absence of improvement, and this showed a compression fracture of the 12th dorsal vertebra. Undoubtedly this would have been seen in the first radiograph if he had been photographed with his spine in flexion.

Dislocations (26 Cases).—

1. *Shoulder-joint* (18 Cases).—This occurs in two phases of the descent: (*a*) With a loop of strop round the arm in a door exit (*see Fig.* 5); and (*b*) On landing if the elbow is not well tucked in (*Fig.* 21).

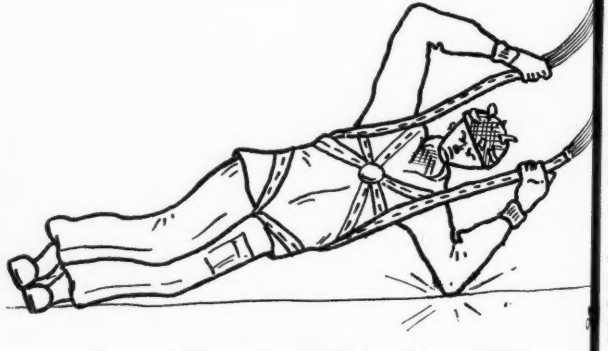


FIG. 21.—Elbows not tucked in with a sideways landing.

With the first mechanism the head of the humerus is driven through the antero-inferior aspect of the capsule, and a subcoracoid dislocation results. One result of dislocation *in extensione* has been seen. After reduction and physiotherapy there is no tendency for these cases to recur.

In the second class no case of recurrent dislocation has yet been noted, but as the dislocation can be of any type, with or without coincident fracture of the great tuberosity, and the total number of cases is small, this is probably fortuitous. A factor preventing recurrence is the excellent muscular development and continual training which the men receive. Nerve injuries have been entirely absent from the series.

The best results are obtained if these cases are reduced at once, and the medical organization of parachute exercises makes this possible. The majority were reduced within one hour, and on the following day physiotherapy was started. After an average time of four weeks these cases have full range of movement and can be put on almost full duties.

2. *Partial or Complete Dislocation of the Acromio-clavicular Joint* (8 Cases).—This usually resulted from striking the point of the shoulder during an awkward roll, or landing with the elbow or hand flung out. The majority had no residual disability after about five weeks. I have heard the view expressed by orthopædic surgeons that a permanent subluxation has no disability, and while this is true of some cases there is a small group who do complain of pain with exercise and expecially when wearing heavy equipment. It is generally agreed that such cases are unlikely to benefit from operation.

Fractures (37 Cases).—

1. *Fracture-dislocation of the Ankle* (12 Cases).—First-, second-, and third-degree external rotation, adduction, and abduction fracture-dislocations of the ankle have been seen. The commonest was a simple transverse fracture of the external malleolus with no displacement, resulting from adduction and inversion of the foot, and Tobin (1941) states that these form 23 per cent of all fractures among jumpers in his series. The third-degree fractures usually resulted from landing on a road, or from 'reaching for the ground' with the toes pointed down (ballet-dance landing) (*Fig.* 22). Tobin (1943) describes a characteristic fracture caused by reaching for the ground in which the posterior lip of the tibia is sheared off with no other fracture. He found that 12 per cent of all fractures were of this type. It is difficult to see how it can occur alone, and Lord and Coutts (1944) speak of the typical parachute injury of feet-apart landings, as a fracture of the lower third of the fibula and posterior lip of the tibia. This is really a third-degree external rotation fracture by Ashhurst's classification (1922) and has occurred twice in this small series.

2. *Fracture of Tibia and Fibular Shafts* (8 Cases)—These are nearly always spiral fractures and tend to occur with feet-apart landings, as, for example, when the man is still trying to kick out of twists. It is seldom that these cases parachute again.

3. *Fractures of the Elbow Region* (2 Cases).—Both these cases were caused by landing with the elbow flung out. One was a fracture of the head of the radius with no displacement, which healed up without excision, and the other was a transverse fracture of the olecranon process, also with no displacement.

Traumatic Synovitis of Calcaneo-cuboid or Cubo-Metatarsal Joint (6 Cases).—This is another injury which appears to be peculiar to parachuting and I have not seen it described elsewhere. It usually follows a landing with the feet not quite parallel to the ground. It is painful, especially after rest, and lasts several weeks, with recurrences after marching or P.T. In the acute stage there is swelling over the affected joint line with tenderness, indicative of strain of the capsular ligaments.

FIG. 22.—'Ballet-dancer' landing.

Radiant heat and rest for a week, followed by graded foot exercises, seems to be the best treatment, though I have had two very intractable examples, one of which developed traumatic arthritis in six months (*Fig.* 23). Novocain injection into the capsular ligaments had no effect.

Bruises of the Coccygeal Region.—Coccydynia is an all too common sequel of a sit-down landing, with considerable pain and disability. Two of these cases were ultimately recommended for excision of the coccyx when all else had failed.

Effects of Excessive Parachuting.—In this division were a number of enthusiasts who, because they were experimenting with new methods or equipment or because they liked it, performed a very large number of descents. Some had made several hundred. There is no doubt that each landing jars the body very considerably, and some of these men have developed marked osteo-arthritis of ankles and knees, and I am certain that the others will show it earlier in life than the average.

Treatment and Rehabilitation.—It has been found that all sprains, however minor, do better if

actively treated from the earliest possible moment, and the practice of allowing sprains to 'get better by themselves' has been discouraged. These minor sprains do not always become painless, and the time spent later in treatment is out of all proportion to the extent of the injury and the dramatic results of early therapy. In those cases with much

FIG. 23.—Traumatic arthritis in the cubo-metatarsal joint.

swelling, rest in bed until the swelling is beginning to subside, and then and in all other cases radiant heat with graded, active foot and ankle exercises, is the treatment adopted.

Nicoll's (1944) contention that the key to success is restoration of muscle power has been proved true time and time again. The man's natural tendency to drift and wait for recovery must be overcome. Intensive non-weight-bearing exercises can start the day following injury in every case, even if in the earlier stages it is no more than bracing the muscles after radiant heat has eased the pain—the 'facilitation' advocated by Ward (1945).

The complete restoration of the shock-absorbing power of muscles is of paramount importance before parachuting can be resumed and is a severe test of recovery. It has always taken longest with the knee-joint, where the lower fibres of the vastus internus disappear in a few days unless backward bracing is one of the first exercises on the list. But a full range of painless movement is essential too, for any attempt to 'spare' a limb in landing throws all the strain on to the other, and injury is almost certain to result. Hence the insistence of the divisional surgeons that all cases of sprain must be sent to the Centre, where the necessary exercises can be prescribed and supervised—men told to do 20 minutes thrice daily, don't.

With the shoulder-joint dislocations treatment was started the day following reduction: deltoid bracing first and then active movements in the sling occupy the first week, followed by exercises against gravity and resistance. Throughout treatment great care is taken to ensure that all exercises are, in fact, active and that no arm swinging is done. Arm swinging always has a passive element from momentum, and by further tearing of damaged muscle delays recovery and causes more final fibrosis. In the later stages games to encourage 'impulsive action' (Griffiths, 1943) are employed, for there is little likelihood of a large passive element in medicine ball games.

Faradism has been employed in two classes of case: (i) To assist in the strengthening of weak muscle, where I consider it has very limited value; (ii) to re-educate a muscle to contract when inhibited by injury. Many men are unable, in health, to consciously brace even a group of muscles, and faradism has been found very useful in educating the patient to the 'feel' of his muscle contracting as a facilitation of active movement.

This division has been fortunate in being able to organize and carry out treatment on lines accepted to-day as being ideal in preventing loss of man-hours from incapacity (Nicoll, 1941). Hospital and X-ray facilities were readily available, and a physiotherapy and remedial P.T. gymnasium with a capable and enthusiastic staff under the constant supervision of the divisional surgeons was conveniently situated in the Centre of the area. To this Centre cases were transferred from hospital and referred direct by medical officers for opinion and treatment. The patients lived with their units and attended the Centre daily or thrice weekly, where physiotherapy and remedial P.T. were carried on side by side. A man was never allowed to feel that he had ceased by sickness, whether the result of parachuting, marching, or football, to be an integral part of the division. He was expected to take part in unit P.T. and training programmes as far as he was able, while still attending the centre for specific exercises. His *esprit de corps*, morale, and discipline were kept at a high level by this means, his training did not suffer, and his main concern was to get back into line with his mates, into the full picture of which he was temporarily seeing only a part.

Treatment produced astonishingly quick recovery and consistently good results, but it would be foolish to draw any hard-and-fast conclusions from this, or to attempt to compare the results with those of any other centre. The men were constantly in tip-top physical condition; they were a selected group and all volunteers, who despised incapacity and who tended to mask subjective symptoms under the veneer of 'toughness." They were a group in whom it did more good than harm to assume an incapacity after injury and to oppose their pleas to be back to full duty until it was certain that they

were better, for the demands of their pride were then satisfied without any feeling on their part that their enthusiasm had been exploited. In an environment of this nature the malingerer was rare, and as often as not was 'cured' by the other occupants of his barrack room.

At the same time, because airborne training is hard, it is not surprising to find that a number of cases discharged from treatment asked to be let off certain items of training because of the residual pain it caused, and, for example, because a man had full range of movement following a dislocated shoulder in three weeks it did not follow that he could perform all the rope-climbing tests even after three months.

SUMMARY

The manner in which the various injuries found after 20,777 jumps by men of the Sixth British Airborne Division were caused is discussed. Most of these were the result of failure to observe the rules of parachuting.

The casualty rate for all injuries was 2·1 per cent, of which 0·5 per cent could not have carried on fighting.

Concussion and sprains constitute 61·6 per cent of all injuries.

Strain of the superior tibio-fibular joint and traumatic synovitis of the calcaneo-cuboid or cubo-metatarsal joints are described as two injuries peculiar to parachuting. A description of the second has not appeared before.

The Divisional Rehabilitation Centre is described and some comments are made, in the light of experience there, on the treatment of the injuries from parachuting and all other injuries which occur in the training of a division.

I am very grateful to Col. MacEwan, D.S.O., O.B.E., D.F.C., T.D., A.D.M.S., of the Sixth Airborne Division, for permission to prepare this paper and for the facilities he has placed at my disposal; to the *New York Times*, *Picture Post*, Photographic News and Keystone Agencies, and the Air Ministry for permission to use photographs; to all the medical officers and surgeons of the Division for their help in the collection of the material and their advice; and to Pte. J. H. Groves, of the Royal Engineers, for the diagrams.

REFERENCES

"Delivering Doctors by Parachute" (1942), *Hygeia*, **20**, 30.
Ashhurst and Bromer (1922), *Arch. Surg.*, **4**, 51.
de Gaulejac, René (1939), *Bull. méd.*, **53**, 258.
Griffiths, H. E. (1943), *Lancet*, **1**, 729.
Lord and Coutts (1944), *J. Amer. med. Ass.*, **125**, 1182.
Nicoll, E. A. (1941), *Brit. med. J.*, **1**, 501.
Tobin, W. J. (1943), *Arch. Surg.*, **46**, 780.
— — et al. (1941), *J. Amer. med. Ass.*, **117**, 1318.
Ward, F. G., *Brit. med. J.*, **2**, 225.

INGUINAL HERNIA

THE UNPREDICTABLE RESULT

By W. J. M. BRANDON, O.B.E.

It is becoming increasingly evident that the inguinal muscular mechanism is now regarded as the key to the problem of oblique inguinal hernia. We must, therefore, obtain an accurate conception of the anatomy and function of this mechanism, together with its capabilities and limitations, before turning to the problem itself.

The credit for this particular approach to the subject in this country must go to Sir Arthur Keith, Sir Heneage Ogilvie, and W. J. Lytle. Keith (1923) described the shutter action of the conjoined tendon and drew attention to the fact that it is not the presence of a patent process of peritoneum that accounts for the frequency of hernia in man, but a weakness in the groin which has resulted from his upright posture. Ogilvie (1937) must receive credit for being the first to realize that the internal ring must be protected by a mechanism not entirely dependent on the simple shutter action of the conjoined tendon and for pointing out that the most potent factor in the production of an oblique hernia, certainly of the acquired type, is a prolapse of the cord. He has attributed the integrity of the internal ring to its close fit round the cord, to the unusual strength of the transversalis fascia forming its margin, to a well-developed conjoined tendon, and to the recoil action of the cremaster, which draws "the whole cord up to the internal ring, even invaginating it into the abdomen", against the thrust of intra-abdominal pressure. As a natural corollary to these views he has asserted that it is essential to restore, and not to interfere with, the normal anatomy and function of the inguinal canal except where the mechanism has been damaged beyond repair. Lytle (1945) has shown that the internal ring has mobility and is protected by "an active closure mechanism in which the ring, under stress, moves upwards and outwards under cover of the internal oblique and transversalis muscles." His explanation is particularly valuable, for it alone can account for the internal ring remaining intact in the presence of a direct hernia—where the posterior wall has been stretched, the cremaster thinned out and distorted, and the conjoined tendon rendered incompetent. These authors have, between them, provided the data for the solution of the inguinal mechanism, and all that remains is to correlate their findings. For this purpose it will be necessary to allude briefly to the anatomy of the adult male inguinal canal.

THE INGUINAL CANAL

The following description has been based on the published work of Ogilvie and Lytle after a careful check both at operation and post mortem.

The inguinal canal lies above the inner half of Poupart's ligament and is covered by the external oblique aponeurosis which splits to form the pillars of the external ring. Medially the external oblique aponeurosis joins the anterior rectus sheath, but it does so a full inch inside the outer border of the rectus muscle, so that for this width the sheath is formed by contributions from the internal oblique and transversalis only. The internal oblique springs from the outer half of Poupart's ligament and the transversalis muscle from its outer third. The

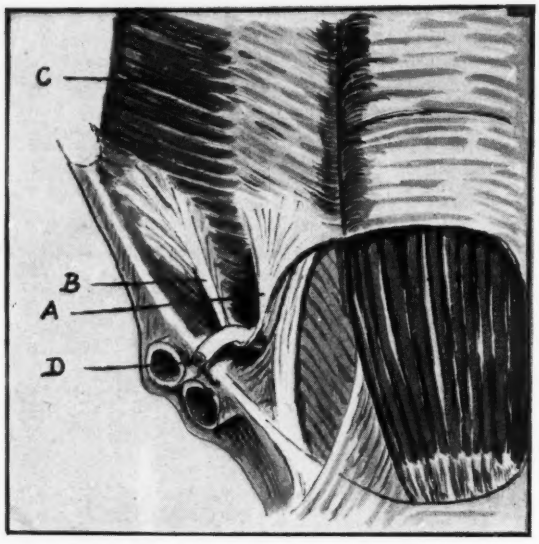


FIG. 24.—Posterior view of a dissection of the lower part of the anterior abdominal wall. A, Inner pillar; B, Outer pillar of the internal ring; C, Transversalis muscle; D, Vas deferens. (*After Lytle.*)

first muscle has the origin of its lowest fibres in front of the internal ring, the second to its outer side. The internal oblique, therefore, covers the ring completely, while the transversalis crosses above it, overlapping it to a varying extent. At this point the muscle layers are distinct, but to the medial side of the ring they blend to form the conjoined tendon, which arches over the cord to be inserted behind it into the pubic crest and the inner inch of the ileo-pectineal line. The conjoined tendon is neither tendinous nor sharply demarcated except at its point of insertion and its lower fibres become thinner and merge with the fibres of the cremaster. The cremaster arises from the middle of Poupart's ligament and the lower border of the internal oblique, and descends over the cord in a series of loops, the longest reaching down as far as the testes. The ascending fibres of these loops pass up along the medial side of the cord and are inserted by a small pointed tendon into the tubercle and crest of the pubis. "In practice these three muscles appear to form one system, through which the descending testis has thrust its way, carrying an abundant covering of muscle fibres with it" (Ogilvie).

The posterior wall of the inguinal canal is formed by the transversalis fascia reinforced at its inner end by the insertion of the conjoined tendon and the reflected inguinal ligament. The transversalis fascia is of considerable strength in this situation and is firmly attached to Poupart's ligament and the ileo-pectineal line. According to Lytle it consists of two fascial layers—a superficial or "transversalis muscle layer", derived from the fascial covering of the transversalis muscle, and a deeper layer which is the true transversalis fascia. The free edge of the transversalis muscle layer forms what Lytle has described as the "middle ring". At the internal ring the true transversalis fascia is continued over the cord as the infundibuliform fascia.

The internal ring lies to the lateral side of the deep epigastric vessels. "The ring itself is not round, but U-shaped and incomplete above it. It has a thick and strong inner margin or pillar, a thinner outer margin, and an angle below. In the adult the opening measures from 12 to 20 mm. in height and from 6 to 10 mm. in breath. It is covered on its anterior surface by the transversalis muscle, the angle of the ring lying just below the edge of this muscle to allow free passage of the cord. The ring is composed of strong U-shaped fibrous strands of varying length, the ends of which are attached firmly as slings to the posterior aspect of the transversalis muscle. On each side of the ring the strands spread out in a fanwise manner; those on the outer side pass up to be attached to the transversalis muscle as far as the anterior superior spine, while those on the inner side gain attachment to the aponeurosis of the transversalis muscle" (Lytle). (*Fig.* 24.)

THE INGUINAL MECHANISM

These anatomical points are all of importance when we come to consider the normal defences of the inguinal canal—a region which must provide unimpeded passage to the spermatic cord and yet withstand considerable variations of intra-abdominal pressure. Nature has provided a defence which varies in strength in direct proportion to the pressure. When the pressure is low or increased gradually, the inguinal canal depends for its security on a simple valvular opening or baffle which acts in much the same way as the oblique insertions of the ureters into the bladder act as baffles, preventing regurgitation of urine when the bladder is distended; but when the pressure is increased suddenly by the contraction of the abdominal muscles an active muscular defence is called into action. The same contraction which increases the pressure guards the canal against its effects.

Whenever the intra-abdominal tension is raised, and therefore whenever there is a *vis a tergo* tending to thrust the abdominal contents through the posterior wall of the inguinal canal or to propel them through the internal ring and along the pathway of the spermatic cord, the external oblique aponeurosis becomes taut, approximating the pillars of the external ring and resisting the tendency of the deeper layers to bulge outwards. At the same time the external oblique aponeurosis pulls on the rectus sheath and steadies it over the rigid pillar of the contracted rectus, so that the deeper muscles are able to exert their maximum contractile effort. The arched fibres of the internal oblique and transversalis muscles straighten, bringing the conjoined tendon down towards Poupart's ligament. The conjoined tendon, however, does not close down

on Poupart's ligament, " like the upper eyelid on the lower," because the tendinous portion, whether it is inserted into the pubic crest and ileo-pectineal line or into the rectus sheath alone, is relatively immobile. So that the straightening of the conjoined tendon which occurs during active contraction is restricted almost entirely to the muscular portion of the tendon (*Fig.* 25). In this way a narrow triangular defect remains, with its apex at the origin of the internal oblique and its base at the point of emergence of the cord. This defect does not constitute a weakness so long as the conjoined muscles retain their tone, for the wider portion of this gap is

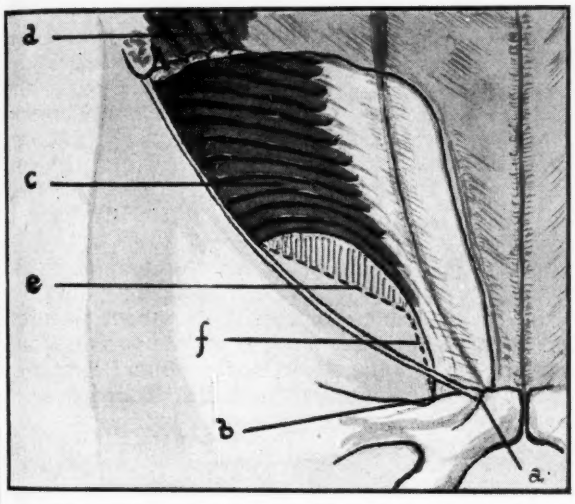


FIG. 25.—Diagram indicating the extent of closure of the conjoined tendon when contracted. *a*, Pubic spine; *b*, Pubic crest; *c*, Internal oblique; *d*, External oblique muscle (cut away); *e*, Shows the straightening of the muscular portion of the conjoined tendon during contraction; *f*, Shows the semi-rigid portion of the conjoined tendon which is relatively immobile.

strongly protected from behind by the insertion of the conjoined tendon, while the slit-like apical portion is protected by the tautened superficial or " transversalis muscle layer " of the posterior wall, which, owing to its attachment below to Poupart's ligament and above to the free border of the transversalis muscle, is pulled over the cord when the transversalis muscle contracts down in front of the cord like the cover of a roll-top desk. The temporarily imprisoned cord, by virtue of its position and bulk, acts as a support or cushion to the posterior wall of the inguinal canal (*Fig.* 26). This simple shutter action provides complete protection to the posterior wall against the outward thrust of intra-abdominal pressure. When it fails, two types of direct hernia occur—a saucer-shaped bulge due to a stretching of the entire posterior wall; or a funicular sac which appears to the lateral side of the insertion of the conjoined tendon and is associated with a localized congenital weakness or defect in the transversalis fascia.

The same mechanism which defends the posterior wall of the inguinal canal actuates the mechanism that protects the internal ring. The internal ring is overlapped completely by the internal oblique muscle, so that this muscle forms a constant protective barrier to the outward thrust of intra-abdominal tension at the ring, and it is left to the transversalis muscle to provide the additional protection under stress. When the transversalis muscle contracts as part of the conjoined tendon, the " U-shaped strands ", because of their arrangement and particular attachment to the posterior

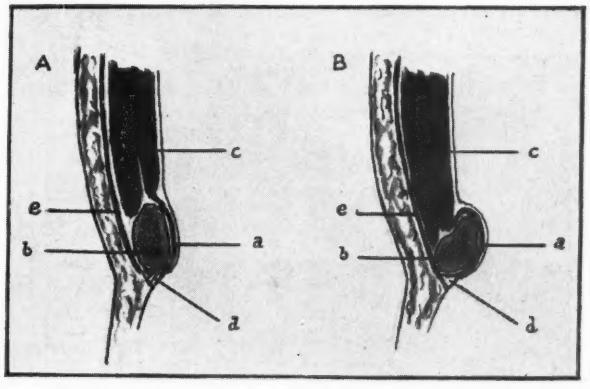


FIG. 26.—Cross-section of the inguinal canal lateral to the insertion of the conjoined tendon. *a*, " Transversalis muscle layer " of the posterior wall; *b*, Spermatic cord; *c*, Conjoined tendon; *d*, Inguinal ligament; *e*, External oblique aponeurosis. A, Resting phase; B, During active contraction. The cord is firmly compressed between the external oblique aponeurosis and the transversalis fascia of the posterior wall, and wedged into the gap between the contracted conjoined tendon and the inguinal ligament.

surface of the oblique fibres of the transversalis muscle, grip the emerging cord by approximating the pillars of the ring and pull the whole ring upwards and outwards. At the same time, the free border of the transversalis muscle straightens and moves downwards, thus constituting the " active closure mechanism or sliding valve," described by Lytle (*Fig.* 27, A, B). This upward and outward movement of the ring serves a threefold purpose: it tenses the deep or true transversalis

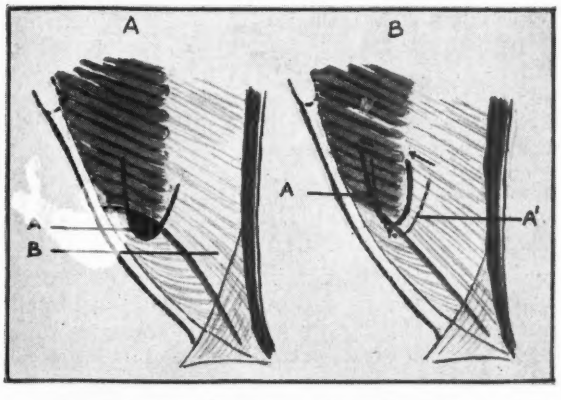


FIG. 27.—Diagrams showing the outline of the internal ring viewed from within the abdomen with the transversalis muscle relaxed (A), and in contraction (B). *a*, U-shaped strands; *a*', Shows position at rest as compared with position during active contraction of the transversalis muscle (*b*). Arrows indicate the extent of movement. (*After Lytle.*)

fascial layer of the posterior wall by lengthening the inguinal canal; it imparts an upward pull on the cord by means of the infundibuliform fascia; and it angulates the cord at its point of emergence

through the ring, so that the thrust of intra-abdominal pressure is diverted from the long axis of the cord on to an impregnable muscle barrier composed of the internal oblique and transversalis muscles, supported by the tautened external oblique aponeurosis (*Fig.* 28, A, B). It is for this reason that the cord does not prolapse under normal conditions and even presents the appearance of being invaginated

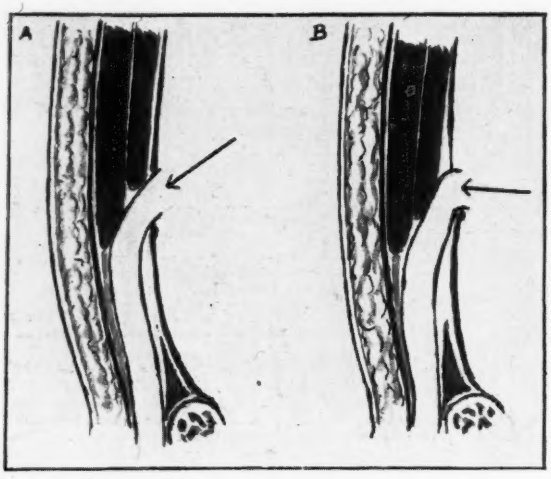


FIG. 28.—Diagrams to illustrate the angle of emergence of the cord at rest (A), and during active contraction (B). Arrows indicate the line of thrust in the long axis of the cord.

into the abdomen against the full force of intra-abdominal pressure. The appearance is in fact due to a puckering of the peritoneum at the site of the internal ring produced by the upward and outward movement of the ring. If this sliding valve mechanism fails to close completely either as a result of stretching of the U-shaped strands due to an inherent weakness in these ligaments or from a loss of mobility of the ring due to muscle weakness, including nerve damage, the outward thrust of intra-abdominal pressure will act in the long axis of the cord and prolapse it. The same thing will happen if the mechanism is caught off its guard.

The cremaster forms an essential part of the protective mechanism. During the resting phase it counteracts a constant pull on the cord due to the weight of the testicle, but during the active phase it contracts and draws the cord upwards so as to provide enough slack in its upper segment, that is the segment of the cord which lies under cover of the internal oblique, to allow the internal ring to ride upwards and outwards without impediment. Thus it prevents a drag on the ring which would tend to stretch the U-shaped strands and therefore immobilize the ring, and it prevents a drag on the cord which would tend to prolapse it. We find, therefore, that, as Ogilvie originally suggested, the most potent factor in the production of an oblique hernia is a prolapse of the cord, and that this prolapse may be due to a defect primarily affecting the valvular mechanism or secondary to an ineffective cremasteric recoil.

The advantage of such an exposition is that it ascribes to each component of the inguinal mechanism a role well within its capacity, and it helps to explain why oblique and direct herniæ can, and usually do, occur independently of each other and even at different periods of life. Furthermore, it indicates that a prolapse of the cord is the basic factor in the actual production of an oblique hernia, thereby providing a working hypothesis from which we can determine the mode of production of a congenital and an acquired hernia. But when we come to consider the principles of repair we find that a knowledge of the function of the inguinal mechanism is insufficient; it leaves us free to accept the current opinion that preservation of the inguinal mechanism is the surest safeguard against a recurrence, or to take the opposite view, that the removal of the sac, even when combined with a repair of the internal ring and a careful preservation of the inguinal mechanism, is no guarantee that the factor or factors which were responsible for the breakdown of what was once a well-functioning protective mechanism will not lead to the breakdown of a repaired one. Our immediate problem, therefore, is whether to bear right or to fork left.

FORK LEFT

As so often happens when we step back from the canvas, not only do we see more of the picture, but we are more able to appreciate its salient features. Let us, therefore, step back from the problem and view the known peculiarities of inguinal hernia in relation to the growing subject and its response to treatment at the various stages in life.

In the newly-born infant the inguinal canal is almost a direct opening through the abdominal parieties, but as the child grows the canal lengthens, till in the adult the internal and external rings are about 5 cm. apart. Normally the processus vaginalis is closed at birth, but should it fail to close a potential hernia is present, and many of these potential herniæ become herniæ in infancy and early childhood. Then follows a latent period during later childhood and adolescence when hernia is comparatively rare, and finally, in adult life the incidence rises once more and many herniæ, obviously congenital in origin, make their appearance for the first time. This periodicity of recurrence must have some significance, for if we accept the presence of a patent process of peritoneum as a constant, it means that a contributory factor must be present before the canal begins to develop and again after the development has been completed, or, conversely, that some factor is present during the development of the canal which controls the internal ring so effectively that the presence of a sac is of little or no consequence.

The presence of a sac in infancy must be regarded as a potential source of hernia, for if there is no sac there is no hernia; but the inchoate state of the inguinal canal must be taken into account, for so long as the canal remains a direct, or almost direct, opening the frequency of hernia is high. The subsequent development of the inguinal canal suggests that Nature, at all events, is aware of this second factor and, after extruding the testis by the most direct route possible, staggers the two rings in order to remove this obvious source of weakness. Some tractive agency must be responsible for the progressive migration of the internal ring in a

lateral direction, and the most feasible one is the U-shaped strand formation described by Lytle. So long as these strands are undergoing progressive shortening, and are therefore maintaining a good tension, the internal ring is fully protected. But once the development of the canal is completed, the incidence of hernia rises again, and the only way we can account for it is that the strands tend to slacken and the internal ring to stretch—a fact which is supported, and more adequately explained, from our study of the adult inguinal mechanism. The question that now arises is whether the presence of a patent process of peritoneum does or does not account for the frequency of hernia in adult man. We find that not only do congenital oblique herniæ make their appearance at this time, but that acquired oblique herniæ also appear at precisely the same period; and it is interesting to note that they both occur at a time when the muscular structures are in their prime, or at worst, just getting past it. We have acquired the habit of dividing oblique herniæ into congenital and acquired types purely on the characteristics of the hernial sac as seen at operation, but is it not possible that the same factor is responsible for both? In other words, is it not possible that the factor which is responsible for the formation of an acquired hernia produces a congenital hernia merely because there is a ready-made sac present to facilitate the process? If this is so, we must prove it; and for this purpose we must envisage the manner in which congenital and acquired herniæ develop.

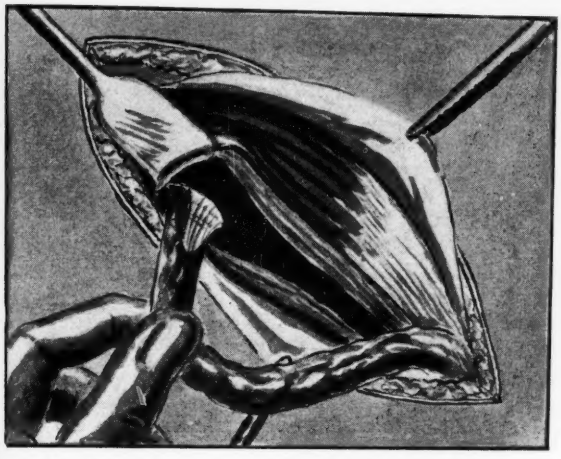


FIG. 29.—Pull on the cord showing a peritoneal pouch lying within the infundibuliform fascia.

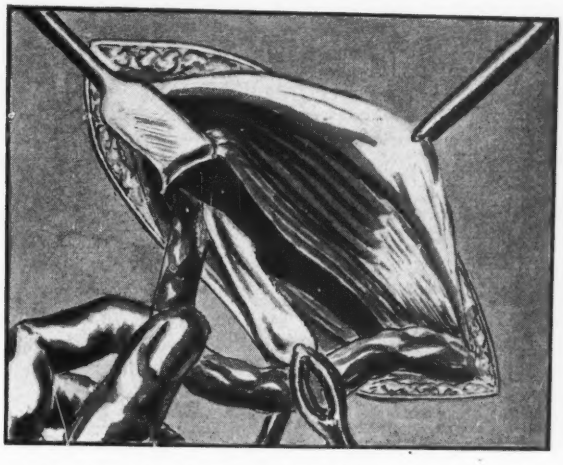


FIG. 30.—Showing an acquired oblique hernial sac which accompanies the cord but has come to lie outside the infundibuliform fascia.

Congenital and Acquired Oblique Hernia.—We know, or at any rate we can surmise with reasonable accuracy, that any breakdown or malfunction of the inguinal mechanism leads ultimately to a prolapse of the cord. If there is a preformed sac present it is bound to prolapse with the cord, so that its well-defined anatomical neck comes to lie distal to the internal ring—a fact which is frequently noted at operation. Thus the new neck of the sac is formed from the peritoneum of the abdominal wall and must be funnel-shaped. This funnel guides the full force of the intra-abdominal pressure through the incompetent valve mechanism against the anatomical neck, which sooner or later dilates and results in a *congenital* hernia. In view of the presence of a ready-made hernial sac this type of hernia makes its appearance quite rapidly.

In the case of an *acquired* hernia the sac has to start from scratch. It can be shown when the normal inguinal canal is laid open, that traction on the cord will pull down a rounded process of parietal peritoneum through the opening of the internal ring, so a prolapse of the cord must do precisely the same thing. At first, the fundus of the acquired sac lies within the infundibuliform fascia, but since this investing sheath, together with the intimately blended structures of the cord, offers a fair degree of resistance to the fundus of the sac, a greater proportion of the expansile pressure will fall on the neck and lumen of the sac. The sac, however, has no true neck and therefore the pressure acts directly on the margin of the internal ring. This stretches the ring still further, and eventually tears the posterior wall of the canal in much the same way as a playing card can be torn across with comparative ease when a distracting force is applied to its edge, though it will offer the stoutest resistance to an attempt to thrust one's finger through it. Once the posterior wall has been torn the fundus of the sac comes to lie outside the infundibuliform fascia and, no longer meeting with any resistance, is able to accompany the cord as an oblique sac with all the known characteristics of an acquired hernia (*vide* Ogilvie) (*Figs.* 29, 30). It cannot, however, be denied that frequently the sac fails to disrupt the infundibuliform fascia and, therefore, lies within it, but in all other respects it remains characteristic of the type.

It will be readily seen that a repetition of this sequence of events can explain how a *recurrent* oblique hernia is formed though the alteration in the terrain will alter the characteristics of the sac.

Principles of Repair.—The main point at issue when we come to consider the repair of an oblique hernia is how much reliance can be placed on a repaired inguinal mechanism. We have noted that in childhood the presence of a sac is essential

to the formation of a hernia, but in adult life its presence is no longer a *sine qua non*. Secondly, we know that simple removal of the sac in childhood gives an almost certain cure, but in the adult simple herniotomy, or any other type of repair, is by no means so reliable.

When we analyse these facts, we find that, though the presence of a sac is an essential component of hernia in childhood, a second factor is present—the undeveloped state of the inguinal canal. If the surgeon attends to the first, Nature looks after the second, and success is assured. In fact, at this period of life Nature is so much on the side of the patient that if the hernia is merely treated by a truss, or even neglected altogether, she does her utmost to produce a spontaneous cure. But once the development of the canal has been completed this strong partisanship on the part of Nature ceases, and if the defence mechanism now fails, it has no natural powers of recuperation. The position, with certain limitations, becomes analogous to that of a mechanic faced with the repair of a broken big-end in a motor car. No mechanic worthy of the name would content himself with a mere replacement of the big-end and then state categorically that it would never give way again. He would true the bearing, make sure that there is no whip in the crankshaft, and test the efficiency of the lubrication system as well as replacing the big-end. Figuratively speaking, the surgeon is in a position to true the bearing and replace the big-end—that is, he can remove the sac and repair the inguinal mechanism—but he has no control over the amount of stretching which may take place in fibrous tissue and he cannot restore a defective muscle action. Therefore, he is is no position to give an assurance that the hernia will not recur.

The Solution.—Here, I must repeat myself, but I do so in the knowledge that it is only a constant drip that will wear away the stone. When we consider the multiplicity of repairs, including simple herniotomy, we are struck by the fact that the only repair which provides a certain cure in adult life is complete closure of the inguinal canal after removal of the cord and testis. It was on this fact that I based my solution; for every repair, with the exception of Schmieden's operation and my own modification of Ogilvie's method of mobilizing the cord in a lateral direction to allow complete closure of the inquinal canal, preserves the inguinal mechanism in some degree; and it is the preservation of this mechanism either wholly or in part that has made the repair of any given oblique inguinal hernia an unpredictable result.

CONCLUSION

If we take one last backward glance at the picture as we depart we see that our first visual impression must have been correct, for there is no other way of explaining why that cunning with the scalpel, which seems so universal when dealing with children, should forsake all but the elect when we turn to the adult.

I wish to express once again my gratitude to Sir Heneage Ogilvie, who, in keeping with the greatest exponents and the best teachers in another sphere, has allowed me to retain my swing yet has enabled me to keep the ball on the fairway.

REFERENCES

BRANDON, W. J. M. (1945, a), *Lancet*, **1**, 167.
— — (1945, b), *Ibid.*, **2**, 812.
KEITH, Sir, A. (1925), *Brit. J. Surg.*, **11**, 455.
LYTLE, W. J. (1945), *Ibid.*, **32**, 441.
OGILVIE, Sir H. (1937), in R. Maingot's *Post-Graduate Surgery*, vol. iii. London.

THE SURGICAL TREATMENT OF CARCINOMA OF THE ŒSOPHAGUS*

WITH SPECIAL REFERENCE TO A NEW OPERATION FOR GROWTHS OF THE MIDDLE THIRD

By IVOR LEWIS

NORTH MIDDLESEX COUNTY HOSPITAL, LONDON

THE œsophagus is a difficult surgical field for three reasons: its inaccessibility; its lack of a serous coat; and its enclosure in structures where infection is especially dangerous and rapid. In the case of carcinoma of this viscus surgery is still more difficult, for several reasons. It involves an extensive resection in a part of the alimentary canal which not only has no serous covering but also no slack. This in itself renders the ordinary procedures of abdominal surgery well-nigh impossible to apply. Moreover, regarded as a thoracic operation its resection is a formidable undertaking in a usually old and starved patient, and more than any other thoracic operation it threatens the surgeon with having both pleuræ opened during its course. The arteries of the gullet are largely longitudinal and in its upper thoracic course anastomose precariously with branches of the inferior thyroid. It is the direction of blood flow rather than its longitudinal course which besets the surgeon—mainly in the upper third. The contents are commonly septic in these cases. Because of the loosely-knit muscle, anastomosis of its walls has with some reason been described as "suturing the unsuturable." The pioneers realized early that, except for a few growths of the cardia, resection with anastomosis seemed out of the question. Attempts at suture of the

* Being the substance of a Hunterian Lecture at the Royal College of Surgeons, London, Jan. 10, 1946.

thoracic œsophagus after resection for cancer all failed, and exteriorization seemed the only solution. The new problem created by this would, it was hoped, be solved by œsophagoplasty—a hope which has not been fulfilled.

HISTORICAL

There are few things in surgery to match the courage and enterprise with which the great surgeons of the last century attacked this problem. First of all the cervical œsophagus; then the cardia by the abdominal route; and finally the thoracic œsophagus was successfully attacked. Much of the work was experimental surgery on animals—usually dogs. As long ago as 1871 Billroth did experimental resections of the cervical œsophagus in animals, and in 1877 Czerny—then Billroth's assistant in Vienna—carried out the first successful resection of the (cervical) œsophagus in man. Seven years later that other famous pupil of Billroth's, von Mikulicz, actually reported a successful plastic reconstruction of the cervical œsophagus after resection for cancer. During the next 20 years (1885–1905) a small number of surgeons, von Mikulicz, von Hacker, Rehn, Sauerbruch, in Germany, Nassilov in St. Petersburg, Biondi in Italy, and Gosset and Faure in France, attempted varied methods. Some of these were experiments on animals and some were " recherches cadaveriques," as Gosset quaintly described them. Indeed, an article by Gosset in 1903 shows such a grasp of the essential principles of œsophagogastrostomy that it well repays reading to-day. But none of these surgeons secured an operative recovery in man. In 1908 Voelcker successfully resected the cardia by an abdominal approach, completing the operation by pulling down the œsophagus and joining it to the stomach. A few more successes by this method followed: Kümmel (1910), Bircher (1918), Gohrbandt (1927), Ingebrigtsen (1933). The essentials of the Torek operation had been carried out 10 years before Torek's case both by von Mikulicz and Faure, but their patients died. Faure's thoracic approach, however, was very like that of a modern upper thoracoplasty, combined with a cervical dissection. The year 1913 was the date of the first successful transthoracic œsophagectomy by Franz Torek. His patient died a natural death 13 years later at the age of 80. A small number of other successes followed, both abdominal and thoracic. In 1933 Grey Turner reported his successful resection of the œsophagus by the cervico-abdominal or ' pull-through ' method with construction of an ante-thoracic gullet. The year 1938 is notable for two reports—Garlock's three consecutive successes by the Torek method, and Adams and Phemister's first successful transpleural, transphrenic resection of the cardia with œsophagogastrostomy. It seems likely that that year will come to be looked upon as the turning point in the surgery of the œsophagus—a year which marked the end of 40 years' wandering after elaborate and ingenious devices and a return to simple, straightforward, and meticulous surgery. Exteriorization, invagination, cutaneous flaps, phrenic flaps, pull-throughs, strippers, mediastinal approaches, Murphy buttons, even endoscopic resections (Seiffert, Moersch), all these must be recognized as methods which, while trying to avoid the acknowledged dangers of œsophageal resection, created new dangers and difficulties of their own. Only with the great advances of the nineteen-thirties in chest surgery and anæsthetics, had the thorax at last been made a place fit for the abdominal surgeon to work in. . . . The rapid increase in the number of resections since 1938 is matched by a steady fall in the mortality. Garlock showed that case after case could be successfully operated on; Churchill and Sweet have shown how low the mortality of these big undertakings can be when carried out with scrupulous care on selected cases.

Outside America, the Japanese surgeon, Ohsawa, must be specially mentioned, because in 1933 he published a series of 20 resections of the lower end of the œsophagus with 8 survivals. The report of this striking achievement was received by Western surgeons almost with incredulity until 10 years later the still larger series and even higher recovery rates of Garlock, and of Churchill and Sweet, confirmed that such results could be achieved and consistently achieved.

Great Britain.—Whilst in America the number of successful œsophagectomies is now considerable, British surgeons have contributed a good deal to ideas on the subject. Wilfred Trotter, by his thoughtful and deliberate craftsmanship, brought the surgery of the pharynx and cervical œsophagus to a point it had never reached before. Grey Turner has insisted for many years that cancer of the thoracic oesophagus must not be crossed off the surgeon's agenda. He has been rewarded not only by his own success by the abdomino-cervical pull-through method, but by the revived interest in the whole subject. W. H. Ogilvie's article in 1938, based on a case done three years before, was a clear exposition of the difficulties and a source of great encouragement. A short but masterly essay on the surgical anatomy of the œsophagus by O'Shaughnessy and Raven in 1934 remains the best thing written on the operative approach. Successful operations of the Torek type have been reported by Tudor Edwards (1935), Allison (1942), Franklin (1942), Muir (1936)—the last-named employed a dorsal stoma. H. A. Kidd (1943) has had two recoveries by the Grey Turner pull-through method. Successful resection for carcinoma of the lower end with immediate œsophagogastrostomy was done for the first time in this country by Vernon Thompson in 1941. G. H. Steele, of Guildford, reported his case in 1943, and Tubbs in the same year; Dickson Wright published another in 1945. Hermon Taylor (1945) has described an interesting modification whereby both stomach and œsophageal stump are transposed to the front of the sternum and anastomosed there.

It will be agreed that this work demands careful record and discussion, as the field is constantly changing and our views are still in some respects tentative. Those desiring comprehensive recent reviews of the whole subject will consult the painstaking symposia of Clarence Bird (1939) and Ochsner and De Bakey (1941). The following notes are more a record of personal experience and impressions than a composite of other surgeons' views.

CASE REPORTS

Case 1.—A. J. L., a nightwatchman of 73.

Admitted Sept. 19, 1940, with difficulty of swallowing and food coming back after sticking at suprasternal notch for one month. Loss of weight but fair appetite. A wasted and melancholy old man. No physical signs.

X-ray Examination: Intrinsic obstruction mid-œsophagus.

FIRST OPERATION (Sept. 20).—*Gastrostomy* under local procaine. No secondaries apparent.

SECOND OPERATION (Sept. 29).—*Cervical dissection*, and a loop of silver wire left around upper thoracic œsophagus.

THIRD OPERATION (Nov. 4).—*Œsophagectomy*. Anæsthetic: right paravertebral block plus nitrous oxide and oxygen (Dr. Nagle). Patient in left lateral position. The whole right 5th rib was resected and the 4th and 6th divided at their necks. The growth was at the level of the left bronchus. The azygos vein was divided and the mediastinal pleura incised. Tapes were passed around the œsophagus above and below and then the growth itself freed. There were considerable adhesions to the left bronchus. Only about three œsophageal vessels had to be tied. The œsophagus was divided with cautery 2 in. above the diaphragm, distal stump ligated and inverted by a silk suture. The pleura was then drawn over the stump by a third suture. The upper third of the œsophagus was rapidly freed and the growth and proximal end encased in a glove finger. An intercostal catheter was fixed in 9th space. The chest was then closed with fine silk—continuous for the costal bed and interrupted for the muscles. He was laid on his back, the cervical wound reopened and the œsophagus hooked up by the silver loop with no trouble. The gullet was now cut off 2 in. above the growth and the remaining stump placed in a subcutaneous tunnel in front of the manubrium sterni, and stitched after a disc of skin had been removed. The cervical wound was closed.

Operation time 2½ hours. 1000 c.c. of blood transfused during operation. Pulse at end 96.

PROGRESS.—His condition caused no concern except for some œdema at the end of the first week. This was apparently due to hypoproteinæmia. His lung expanded well and the wounds healed without incident. A small purulent discharge followed removal of the pleural tube on the tenth day—drying within a week. He refused to co-operate in using a rubber tube for an œsophagus and was generally in a miserable state. He was discharged in January, 1941. He died six months after the resection, probably from secondaries.

Comment.—This appears to be one of the oldest patients to survive œsophagectomy. It is remarkable how little he was upset by it. The growth was rather advanced and I was not surprised at his early death.

Case 2.—V. G., age 64, a chef.

Admitted Oct. 3, 1941, with dysphagia for seven months. Lost weight—3 st. in six months. Had already had a gastrostomy, but could still swallow fluids. Food sticks at manubrium, he says. No physical signs.

X-ray Examination: Organic obstruction from 9 cm. to 5 cm. above diaphragm.

Œsophagoscopy (Oct. 11): Papilliferous new growth at 35 cm. Still some lumen. Biopsy: squamous carcinoma—especially basal cells—no cell nests.

FIRST OPERATION (Oct. 17).—*Dissection of cervical œsophagus*. Local infiltration. Stripped down towards arch of aorta. Silver wire looped around œsophagus. Wound closed.

SECOND OPERATION (Oct. 20).—*Torek œsophagectomy*. Paravertebral block, gas and oxygen, then cyclopropane (Dr. Quayle).

The whole of the left 5th rib was removed and the 4th and 6th ribs divided. The growth was mobilized and the œsophagus divided below it. The right pleura was slightly torn during this—plugged with damp swab. Œsophagus was brought out through neck and wrapped in a rubber glove finger. The chest wall was closed in layers, water-seal drainage. Growth resected, œsophageal stump brought through tunnel in front of manubrium. In spite of an interruption of three-quarters of and hour during the operation due to respiratory difficulties, the patient's condition at the end was very fair. Two pints of blood was given.

PROGRESS.—The next day his condition was fair; the small right pneumothorax was aspirated. His extremities were warm, pulse rapid (120), but of very fair volume. On the third day arrhythmia of the heart was present—the pulse being in threes and fours. The radiograph showed full expansion of lungs. In the next two days his respirations increased, moist sounds developed at the bases, and he died six days after the operation.

Post-mortem examination showed much purulent bronchitis, but no consolidation. There was no pleural infection.

Comment.—I now think this case might have been saved by timely and repeated bronchoscopic suction. The cardiac arrhythmia, noted by various surgeons in some cases of œsophagectomy, probably had little to do with his death.

Case 3.—F. B., age 43, electrician.

First attended out-patients' Aug. 29, 1942, complaining of slight discomfort in swallowing, particularly a raw feeling in the back, between the left scapula and the spine.

X-ray Examination: "No delay in the passage of a barium bolus with the first swallow" (*screening* only).

Œsophagoscopy (Sept. 18): An ulcer ¾ × ½ in. at 28 cm., two-thirds of lumen still open. Biopsy showed squamous- and polygonal-celled carcinoma of the œsophagus with no horn formation.

His symptoms were so slight at this time that he was unwilling to have anything done.

Second X-ray Examination (Sept. 18): *Films* were now taken, and although there was still no obstruction, the ulcer showed now as a large fleck in the mid-œsophagus.

Admitted to hospital, Oct. 8.

FIRST OPERATION (Oct. 12).—Janeway gastrostomy. No sign of abdominal spread.

SECOND OPERATION (Oct. 19).—Cervical dissection of the œsophagus down to the arch of the aorta. Silver wire loop placed around it.

THIRD OPERATION (Oct. 21).—Anæsthetic (Miss Faux): gas, oxygen, and ether, with cyclopropane.

Torek œsophagectomy: The approach was through the right pleura; the whole of the 6th rib was removed, the vena azygos major divided between ligatures, and the mediastinal pleura over the œsophagus divided. The œsophagus was mobilized. There were no malignant glands, but the growth was beginning to show white under the muscle-fibres. An apparently complete and adequate removal was secured 6 cm. beyond, above, and below. The distal stump was crushed, sutured, and invaginated; two-thirds of the thoracic œsophagus with growth was removed, the cervical stump was brought up through the root of the neck and fixed over the sternum in the usual way. Water-seal drainage was employed for seven days.

PROGRESS.—The patient made an excellent post-operative recovery. Subsequently various minor procedures were carried out to prevent stricture of the upper stoma due to sloughing. The distal stump of the œsophagus was also brought through the abdominal wall with a view to using it for constructing an ante-thoracic œsophagus later, as advocated by Wookey. While this was being considered, however, he developed a nodule

in the cervical œsophagus, and an enlarged liver. He died 10 months after the resection.

At autopsy there was a huge liver with umbilicated secondaries. There were malignant glands along the whole posterior mediastinum. There was a secondary the size of a cherry in the upper œsophageal stump. The abdominal pre-aortic glands were involved. No metastases in the lungs.

Comments.—

1. This case shows the importance of œsophagoscopy *in addition* to barium swallow, before excluding carcinoma, where the symptoms are strongly suggestive.

2. This was the earliest cancer of the gullet I have had; diagnosed in the pre-obstructive stage. In no case have I felt so satisfied of having resected cleanly and completely well beyond the growth, which could only just be seen from the outside of the œsophagus. The removal of the whole distal œsophagus might have made a difference here. The rapid longitudinal lymphatic spread and the apparently high biological malignancy of any cancers of the œsophagus are no doubt closely related.

Case 4.—Mrs. A. C. M., housewife, aged 56.

Admitted July 14, 1944. Always had good health until a month before admission, when she noticed some difficulty in swallowing which was not very serious. No loss of weight. A short, alert, healthy-looking woman, who could still swallow most ordinary food with little difficulty. Clinical examination negative.

X-ray Examination: Carcinoma involving lowest 2 in. of œsophagus.

Œsophagoscopy: Exuberant neoplasm lower end of œsophagus (at 30 cm.—a short patient). Histology: Adenocarcinoma.

OPERATION (July 19).—Left transpleural œsophagectomy with œsophagogastrostomy, in one stage. Anæsthetic (Dr. Faux): Endotracheal tube, closed-circuit ether and oxygen, respiration 'controlled' during latter half of time. The standard left-sided resection with œsophagogastrostomy as later described, was then performed. The lowest 2 in. of œsophagus was a solid cylinder of growth, areolar tissue outside condensed but not adherent. Two pints of blood was transfused during operation. Condition at end of operation was very good. Pulse 84.

PROGRESS.—Two days after operation she started regurgitating some "black fluid" every time she coughed, which proved to be stale blood and gastric contents (16 oz. residue) and caused some anxiety. It appeared that the post-operative œdema was enough to constrict the hole left in the diaphragm. It was treated by gentle suction and washing out through a Ryle's tube twice a day. On the fifth day, to spare her veins, a jejunostomy was done under a local anæsthetic and the opportunity taken to feel the gap in the diaphragm. It was not unduly tight. However, a large catheter was passed up into the thoracic stomach, with its lower end in the duodenum. This helped to keep the dilated upper chamber drained till the stomach regained its tone. The gastric contents steadily became cleaner, the emptying was studied by small barium swallows and as soon as it was satisfactory—on the ninth day—she was allowed to take fluids. The drainage from the pleura was only 3 or 4 oz. in all, and the intercostal tube was removed after two weeks as the discharge was clean. The jejunostomy tube was taken out after three weeks. She got up on the seventeenth day.

Her wounds healed by first intention. Discharged on Aug. 20, 1944, taking full ordinary diet.

She remained very well with no postural regurgitation, and doing her ordinary housework for about nine months. She then developed a right recurrent laryngeal nerve paralysis, with nothing to account for it. Six weeks later a mass appeared in the right posterior triangle of the neck. She died with recurrences in the neck 14 months after the operation.

Case 5.—J. B., age 42, fishmonger.

Admitted Aug. 3, 1944. Onset with hiccup 10 weeks before admission, soon followed by difficulty and substernal pain on swallowing solids, and the food sticking halfway down the breast bone. Could still swallow a little fluid. General condition very fair. Thin, scaphoid belly. B.P. 170/100. No physical signs.

X-ray Examination: Intrinsic obstruction distal third of œsophagus a little above diaphragm.

Œsophagoscopy (Aug. 5): At 37 cm. is a carcinomatous ulcer. Laterally mobile. Biopsy showed tubular epithelial structure in a rather fibrous stroma.

By Aug. 8 he seemed to be getting nothing through, his pulse was small and rather rapid (90–100), and pyrexia (99–100°)—nothing apparent to account for this.

FIRST OPERATION (Aug. 9).—Local field block procaine. Upper laparotomy.

1. Exploration—no evidence of secondaries in belly.

2. Large vessels—left gastric and vasa brevia tied and divided.

3. Witzel jejunostomy, transomental.

SECOND OPERATION (Aug. 16).—Assistant, Mr. Kirz. Closed-circuit cyclopropane (Dr. Faux).

Left thoracotomy through bed of 8th rib. There was a little turbid fluid in the pleura. A mass the size of a plum in the lower 2½ in. of œsophagus, infiltrating the diaphragmatic hiatus. Gullet was freed above and tape passed around it. The diaphragm was then divided. It was found that a good deal of plastic peritonitis had occurred (in one week) around the stomach; its final freeing involved a deal of delay. The growth invaded the posterior mediastinum and the right pleura, and on removal left a gap in the pleura 1 × ½ in. The margin of the hiatus also was removed in one piece with the œsophagus. An end-to-side œsophagogastrostomy was performed 1 in. below aortic arch by the method described. The patient died shortly after, apparently of circulatory failure resulting from respiratory failure and shock.

Comments.—At autopsy no cause was found for this patient's pyrexia except the rather large and rapidly growing cancer itself. (Note the fluid in pleura.) The right lung was partly airless from the open pneumothorax. A tough and shaggy clot the size of a fig was found in the right auricle adherent to the auricular appendage, extending through the tricuspid valve into the pulmonary artery. This was apparently ante-mortem and must have formed in the last hour of life, due to the failing respiration and circulation. Whether a cure is ever to be expected in a case extending so far beyond the wall is doubtful. But in a favourable subject the operation seemed worth attempting in view of the full palliation to be expected should he survive.

The disadvantage of doing any preliminary operation on the stomach in a *left* transpleural œsophagectomy was amply brought home to me in this case. As the diaphragm can be opened wide a one-stage procedure is quicker and better.

Case 6.—P. R., a metal-polish worker, aged 66.

Admitted on Aug. 4, 1944. Always healthy until four months before admission, when he began to get difficulty with swallowing. A wasted, rather pale man, who could only swallow fluids.

X-ray Examination: Neoplastic stricture of middle third of œsophagus at the level of the bronchus (*Fig.* 31).

Œsophagoscopy: A carcinomatous stricture at 32 cm., papilliferous, reasonable lateral mobility. Histology: Squamous carcinoma.

FIRST OPERATION (Aug. 7).—Preliminary laparotomy. No secondary spread. Therefore the upper half of the stomach was mobilized. A Witzel jejunostomy with a No. 12 catheter completed this short operation.

SECOND OPERATION (Aug. 28).—Transpleural œsophagectomy under ether and oxygen anæsthesia, intratracheal tube, CO_2 absorber (Dr. Faux). A right transpleural resection with œsophagogastrostomy at level

FIG. 31.—*Case* 6. Radiograph after opaque swallow.

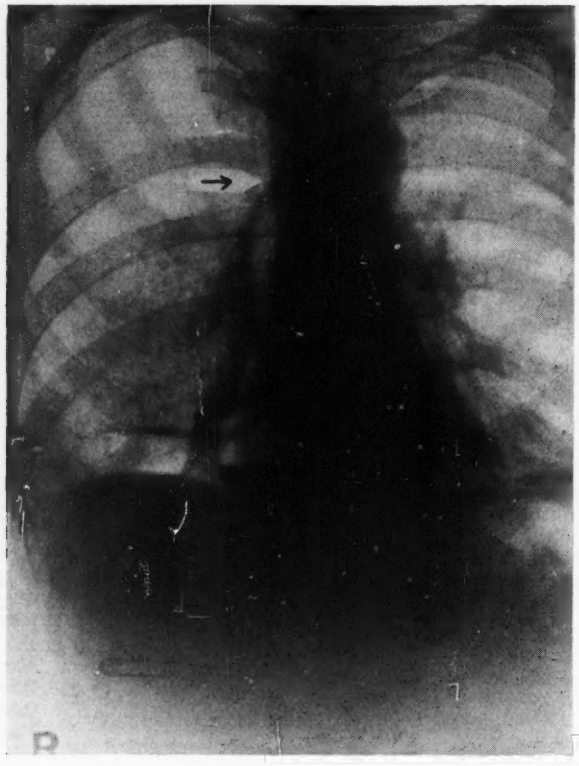


FIG. 32.—*Case* 6. Radiograph of chest, showing anastomosis high in right pleura. Note barium in stomach.

FIG. 33.—*Case* 7. Radiograph after opaque swallow.

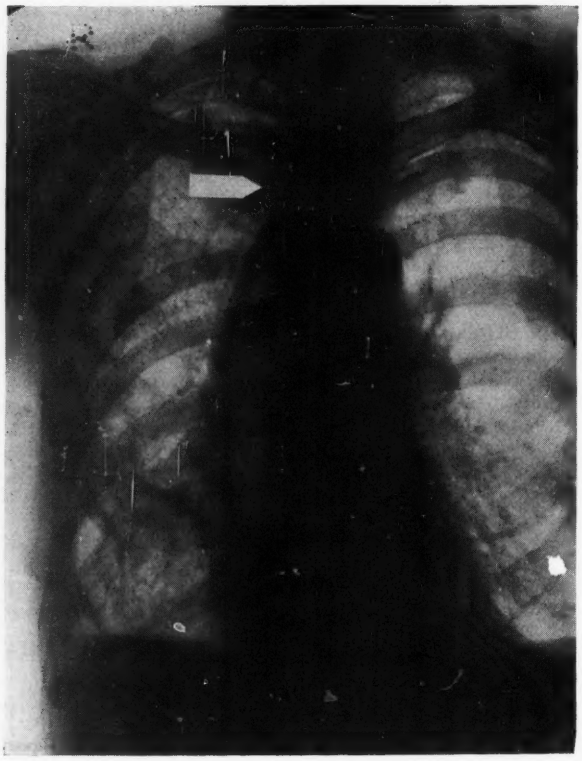


FIG. 34.—*Case* 7. Radiograph of chest, showing stomach in right pleura. Anastomosis at level of manubrium sterni.

above vena azygos major was performed. The growth was found to extend from just below the vena azygos major for 2½ in. distally. Several lymphatic glands were involved. Condition at the end of operation was good.

PROGRESS.—Two days after operation some œdema developed at the bases of lungs, which cleared up after a pint of concentrated blood-serum. (Blood-protein had fallen to 5·5 per cent). For the first fortnight he was only allowed sweets or ice by mouth. The jejunostomy was ample for his sustenance—he was getting milk and glucose, 4 to 6 pints a day, by this route. From the second day a Ryle's tube was passed into his stomach daily, the contents aspirated, and the stomach gently washed out. On the fourteenth day he began feeds by mouth, increasing steadily as gastric emptying was shown to be good by X rays (*Fig.* 32). He was allowed to get up from the seventh day and was walking downstairs and into the garden on the twelfth day. The intercostal drain gave no trouble and was left out at the end of two weeks. There had been only slight infection, by *B. pyocyaneus*. On discharge he had a good appetite, was able to eat anything without discomfort. In the next three months he gained 34 lb. No regurgitation or other disability from his thoracic stomach. He has remained very well.

Case 7.—F. H., a retired crane-driver of 67.

Admitted on July 18, 1945. Difficulty with solids seven months, liquids three months. Lost much weight (about 60 lb.). Nine months ago he had been admitted to a sanatorium because he had a cough and some old calcified shadows in the right apex, but was discharged as a "pneumonitis". He could now only swallow milk or soft foods.

X-ray Examination: Filling defect in middle third, about 1½ in. long (*Fig.* 33).

Œsophagoscopy: Stricture at 30 cm. admits a quill. Lateral mobility good. Biopsy: Squamous carcinoma.

FIRST OPERATION (Aug. 17).—*Mobilization of stomach and jejunostomy*. No secondaries. The stomach was mobilized as described later. Its upper reaches near the cardia, however, were not freed, as it is believed that separation here will only result in denser adhesions. A Witzel jejunostomy using a No. 12 catheter, which was surrounded by omentum. The abdominal wall was closed with fine nylon sutures.

SECOND OPERATION (Aug. 27).—Assistant, Mr. Kirz. Anæsthetic (Dr. Parry Brown): Pentothal 1 g; closed cyclopropane with cuffed endotracheal tube. The right 6th rib from its neck to its cartilage was removed. On opening out the retractor the 5th rib cracked and the 7th was divided. The growth was easily palpable, extending downwards from the vena azygos major for 3 cm. There were no obvious glands involved. The œsophagus was then dissected free except for the deep aspect of the growth, where it was adherent to the left pleura; so its freeing was left till later. The stomach was then brought up as described, through the enlarged hiatus, with no great difficulty, but considerable new adhesions—very vascular—had already formed in the 10 days since the first operation. The lower œsophagus and stomach could now be lifted into the wound and so the cancerous portion dissected out cleanly. A piece of the adherent opposite pleura, however, came away with the growth. This had been anticipated and controlled respiration was maintained throughout from now till the chest was closed. The operation was completed as described; the stomach margins were sutured over the anastomosis rather firmly at the end; the patient remained in good condition throughout.

PROGRESS.—The temperature only exceeded normal once after the operation, and the pulse remained of good volume and rate 80. Forty-eight hours after the operation he was coughing up yellow phlegm, however, and the next day, as there was some opacity of the bases, I did a thorough bronchoscopic cleansing of both bronchi, leaving in 60,000 units of penicillin. As the prevailing bacterium was a pneumococcus he was given 60,000 units of penicillin daily via the cricothyroid membrane for three days. The phlegm rapidly diminished. On the evening of the eighth day he had a sudden cardio-vascular attack with pallor, dyspnœa, and tachycardia. The pulse became rapid and the beats alternating. He improved during the night and progressed well thereafter. He was allowed fluids from the tenth day. The intercostal catheter came out after 10 days. The jejunostomy developed a bad leak, and kept him in longer. He was discharged very well and quite healed after two months. *Fig.* 34 shows the stomach in right pleura and the anastomosis at the level of the manubrium sterni. He could swallow everything except lumps of meat—which stuck.

I inspected his stoma later. Quite healed. No sutures seen. It was the size of a little finger. Dilated from size 11 to size 18 bougie.

Comments.—

1. It is interesting that adhesions had formed round the stomach in 10 days which took a good deal of separating, but did not seriously interfere with the second stage.

2. No satisfactory explanation was found for his sudden distress on the eighth day. It was probably a cardiac disturbance due to the vagal damage.

3. The narrowness of the stoma was most likely the result of the rather tight investing suturing of the stomach margins in this case.

DISCUSSION

Radiotherapy.—There seems little doubt that many cases of squamous carcinoma of the œsophagus are radiosensitive and in themselves should respond to X radiation.

L. J. P.-M., a frail little woman of 68, was admitted to the hospital in October, 1937. She complained of dysphagia and wasting: 10 months. X-ray examination showed a filling defect ¾ in. long in the œsophagus at upper border of the manubrium. On œsophagoscopy I found a typical carcinoma with raised edges. Section showed a squamous carcinoma. Dr. Bromhall gave her a course of X-ray therapy—4000 r in all. There was a good deal of general reaction. A year later she had gained 2 st. in weight and looked very well. She had no symptoms. I œsophagoscoped her in 1943 and again last year. About 1 in. below the cricopharyngeus she has a smooth supple crescentic web—the scar of the old lesion. The œsophagus at this point is the calibre of the little finger rather than the thumb, but otherwise there is no trace of her ever having had a cancer.

I am indebted to Dr. Bromhall for her notes of the case.

This case, well and free of recurrence after eight years, shows what can be done in the upper third where the gullet is fairly superficial. Baum has had a case symptom free for six years and Pohle for seven years—the former died of metastases, however, after nine years. The adenocarcinomas of the lower end are not only inaccessible to adequate radiation, but often of a type, as in the stomach, which rarely responds. What of the squamous carcinomas of the middle third? About a third of them are of low differentiation, and by comparison with those of mouth and pharynx should be radiosensitive. But the crux of the problem here is that the growth is approximately 11 cm. from the anterior chest wall and 10 cm. from the posterior. Using 200 kv. radiation the depth dose is only about one-third of the skin dose. It thus appears to be physically impossible to apply *to the tumour* an average

'sterilizing' dose without exposing the patient to more radiation than he can stand. On the other hand radium, both intracavitary and interstitial, has so frequently either had no effect or else has caused death from perforation into trachea, bronchus, or mediastinum that it has virtually been given up. With the exception of Guisez no one has claimed any cures, and even he now admits its value is palliative only. It seems, therefore, that in the upper third radiation is occasionally curative; in the middle third the growths are frequently of a radio-sensitive type, but they cannot be effectively treated because of their depth; whilst in the lower end the adeno-carcinomas are both relatively inaccessible and relatively insensitive. As a palliative measure radiation can only justify itself if it renders a gastrostomy unnecessary. Although some have claimed that this can be achieved in half the cases, in my experience it is exceptional. I think the 'direct' irradiation of a growth found inoperable, through the operation wound, combined with lateral anastomosis (œsophagogastrostomy) is a treatment well worth pursuing.

The Aims of Cancer Surgery.—The aims of radical cancer surgery are: (*a*) To cure the disease; while (*b*) Rendering the patient's life useful and enjoyable—or at least bearable.

These two aims are always to be borne in mind by the surgeon and the effect of the operation explained to the patient beforehand. Frequently *both* aims cannot be fully achieved as, for example, in carcinoma of the rectum. Indeed in carcinoma of the pelvi-rectal junction it is still a matter of dispute even amongst surgeons as to how far the first objective should be compromised by the second consideration—i.e., the decision between a conservative removal and an abdomino-perineal resection will often depend on how unpleasant the patient considers a colostomy. The aim of palliative cancer surgery, however, is purely to alleviate the patient's symptoms—to reduce his discomfort. It may or may not prolong his life.

How do the various procedures for carcinoma of the œsophagus fare by these criteria? Palliative radiotherapy we have already claimed is only worth while if it is likely to preserve the swallowing. Gastrostomy is indicated when *complete* obstruction is impending in an inoperable carcinoma. Intubation with a Souttar's tube, now so seldom done, is in fact a much more satisfying palliative operation in the cases where the tube remains in position. As for the radical procedures it must be remembered that surgeons are so far still working on the purely technical problems of radical resection. It may well turn out that when these problems are solved, the cure rate will still be low. That is what has happened in the case of carcinoma of the stomach. If this should be so and the great majority of cases be destined to die of recurrence within a year or two, it is very important that the 'curative' operation which the patient has undergone should also be palliative when recurrence ensues; or at least that it should not actually increase his discomforts.

THE LOWER END

Judged by the above criteria the present position with reference to carcinoma of the lower end is very satisfactory. Not only does the resection with œsophagogastrostomy satisfy the postulates of Halsted for the removal of cancer, but it also gives the best possible alleviation of symptoms.

The early successful resections of cancer of the cardia (i.e., abdominal œsophagus) were done by the purely abdominal route (Voelcker, 1908; Kümmel, 1910; Bircher, 1918). This entailed pulling down the lower œsophagus into the abdomen and anastomosing it to the stomach or jejunum. This procedure will always remain dangerous, as it must result in an anastomosis under tension. Nevertheless, as the piece resected was short (no doubt unduly so) about 40 per cent of the cases recovered. Sauerbruch, in 1905, published his ingenious *Einstulpung* or intussusception operation for cancer here. He had no success, but Voelcker and Ohsawa had one each. Ohsawa's other cases, if limited to the cardia, were done by an extended abdominal approach, displacing the left lobe of the liver and enlarging the hiatus so as to enter the posterior mediastinum. In cases where the growth involved more than a centimetre or two of the lower œsophagus, however, he carried out several successful "thoraco-laparotomies" with immediate œsophagogastrostomy. Although Biondi (1895) and Gosset (1903) had worked out the essential steps of transthoracic transphrenic œsophagogastrostomy, it was not until 1938, when Adams and Phemister described their successful operation in man, that the procedure became recognized as the standard method. Their work was based on animal experiments and the principles were confirmed by the experimental work of Noland Carter et al. (1938).

The Principles of Œsophagogastrostomy.—For growths of the lower end the left thorax is freely opened through the bed of the 8th rib. The phrenic nerve is paralysed. The œsophagus is mobilized, the diaphragm is freely slit from the hiatus outwards. The upper half of the stomach is mobilized and brought up into the pleural cavity. The following are essential:—

1. Adequate resection *en bloc*.
2. Removal of all tension from the suture line.
3. Avoidance of the least soiling.
4. An anastomosis which is end-to-side, two-layered, precisely stitched with interrupted sutures.
5. Just as the sheet-anchor in abdominal anastomoses is the serous coat, so in the œsophagus it is the *mucosa* (*see Fig.* 44). This is thick and comparatively strong.
6. Water sealed drainage and early expansion of the lung.

As for needles, Adams, Escudero, Aronsohn, and Shaw (1938) lost 4 out of 13 dogs through using a cutting needle for the anastomosis. The method of inkwell implantation was shown by Noland Carter's experiments to be uniformly followed by stricture. This is a pity, as it promised to be a neater proposition than an edge-to-edge anastomosis.

The steps of abdominal surgery for cancer—viz., radical resection, mobilization to secure approximation without tension, anastomosis—have thus been successfully applied to cancer of the lower end by throwing the abdominal and thoracic cavities into one and mobilizing the stomach.

THE MIDDLE THIRD

In the case of the Torek operation the position is very different. If there were a high prospect of cure then patients might face their discomforts with equanimity. However, a large proportion of cases are likely to recur early. These will therefore have undergone a formidable operation which not only has failed to cure, but has actually added to the misery of their remaining months. For they have probably had a gastrostomy earlier than they needed it and also had to suffer an additional stoma discharging several ounces of saliva on their chest wall every day. It thus seems imperative to devise an operation which shall both be surgically adequate and also preserve the swallowing. The simplest attempt to deal with this is a rubber tube joining the two distant stomata. This is uncertain, clumsy, and distasteful to some ; too troublesome for others. The construction of an antethoracic *ersatz* œsophagus (jejuno-cutaneous) is another solution. This, however, means multiple operations lasting perhaps two years. It is very liable to blockage, infection, and fistulæ. The mortality from such reconstruction operations alone is considerable (over 20 per cent). The most weighty objection of all is that many of the patients will have died of recurrence before the operations can be completed. The number of Torek cases which have acquired a completed antethoracic œsophagus must be very small. Therefore surgeons have been trying to work out other procedures which constitute a different operation rather than the methods of modifying the functional results of the Torek described above. One is Garlock's recently reported method (1944) of transposing the upper œsophageal stump on to the outer side of the aortic arch, bringing up the stomach as in lower-end cases and making the anastomosis at the level of the arch. The drawback to this, in addition to the drawbacks inherent in the left pleural approach for these cases, is that the blood-supply of the upper stump, mostly descending from the inferior thyroids, is jeopardized. Moreover, the aortic arch interferes with the fixation of the stomach to the chest wall.

Hermon Taylor has applied the method which Kirschner tried for impassable simple stricture—mobilizing the stomach, bringing it up in a subcutaneous tunnel in front of the sternum to meet the œsophageal stump, and performing an anastomosis there. In the case of his which survived, the anastomosis broke down, leaving a gap which had to be bridged by a rubber tube. To complete the whole operation in one stage is a formidable undertaking ; the security of the anastomosis seems none too good, and again the blood-supply of the upper œsophageal stump must cause anxiety. (Most surgeons who have done several Torek operations have seen the tip of an upper end slough.) Although in the last few years a return to basic principles has almost solved the problem of sepsis in intrathoracic anastomosis, the results are not so good as entirely to preclude further trials with exteriorization.

Right or left pleural approach? For growths of the lower end of the œsophagus and of the cardiac end of the stomach involving the œsophagus, the cleft transpleural operation of resection with œsophagogastrostomy has become standardized. For growths of the mid-œsophagus also most surgeons have used the left transpleural approach. This is partly due to Torek's example, and partly due to the fact that the lymphatic spread is chiefly distal in the œsophageal wall, and the belief that as this is so the only way the gullet beyond the growth can be freely removed is through the left pleura. It has been claimed that the rational way to remove a carcinoma of the mid-œsophagus *with involved left gastric glands* is by a monobloc dissection through the left pleura and diaphragm. As Churchill and Sweet (1942) have pointed out, however, it will probably be found that few if any such cases are really operable. What is required in cases without intra-abdominal glandular involvement is removal of all the œsophagus down to the cardia. This is perfectly feasible through the right pleura, as first shown by Franklin at Grey Turner's clinic. Thus, if this last argument is met, the question of which side for the mid-œsophagus can be settled, as it should be, purely on considerations of approach.

The advantages of the right transpleural approach are :—

1. A far better accessibility of the upper two-thirds of the thoracic œsophagus. (This is obvious on reference to the transverse sections of the thorax in any anatomy text-book.)

2. Only the vena azygos major has to be divided to lay bare its whole course.

3. The aortic arch (and to a large extent the descending aorta), instead of being an obstacle, becomes a safety barrier between the surgeon and the other pleural cavity. Instead of separating the growth bluntly and blindly from behind the arch, it can be dissected under full vision.

The side chosen for the operation should be that giving the better exposure. Therefore, to operate on the mid-œsophagus through the left pleura is as unanatomical as it would be to operate on the lower end through the *right* pleura. By adopting the method to be described the question of lymphatic spread in no way affects this general proposition.

A New Procedure for Mid-thoracic Growths

Repeated dissections of the cadaver showed that the whole of the distal œsophagus could be removed through the right pleura. As an extension of this, dissections were made to see whether the stomach as well could be brought up through an enlarged hiatus. By first mobilizing it through the abdomen, it was found that the fundus could be actually brought as far as the apex of the pleura. Thus it seemed possible not only to remove the œsophagus, but also to complete the operation by an œsophagogastrostomy at any level demanded.

Stage I.—An upper left paramedian laparotomy is done. The abdomen is carefully explored. If there are no metastases the greater curvature of the stomach is freed in its upper half. The vasa brevia, left gastro-epiploic artery, and the omentum are divided well away from the stomach, leaving a vascular arch attached to the greater curve. The gastro-hepatic omentum is then divided, again well away from the lesser curve, and the left gastric artery is tied and divided *near its origin*

(*Fig.* 35). To reduce inflammatory reaction and adhesions, fine silk should be used throughout and the most careful hæmostasis secured. Finally, a loop of gut about a foot down the jejunum is chosen and a size 10 catheter inserted by Witzel's method. This is brought out, surrounded by omentum, through the lower end of the wound. (If there are metastases present, all that is done is a Janeway gastrostomy.)

For the 10 or 15 days after the first stage every effort is made to improve the patient's nutrition by a high-carbohydrate, high-protein diet, with extra vitamins. The jejunostomy makes this possible.

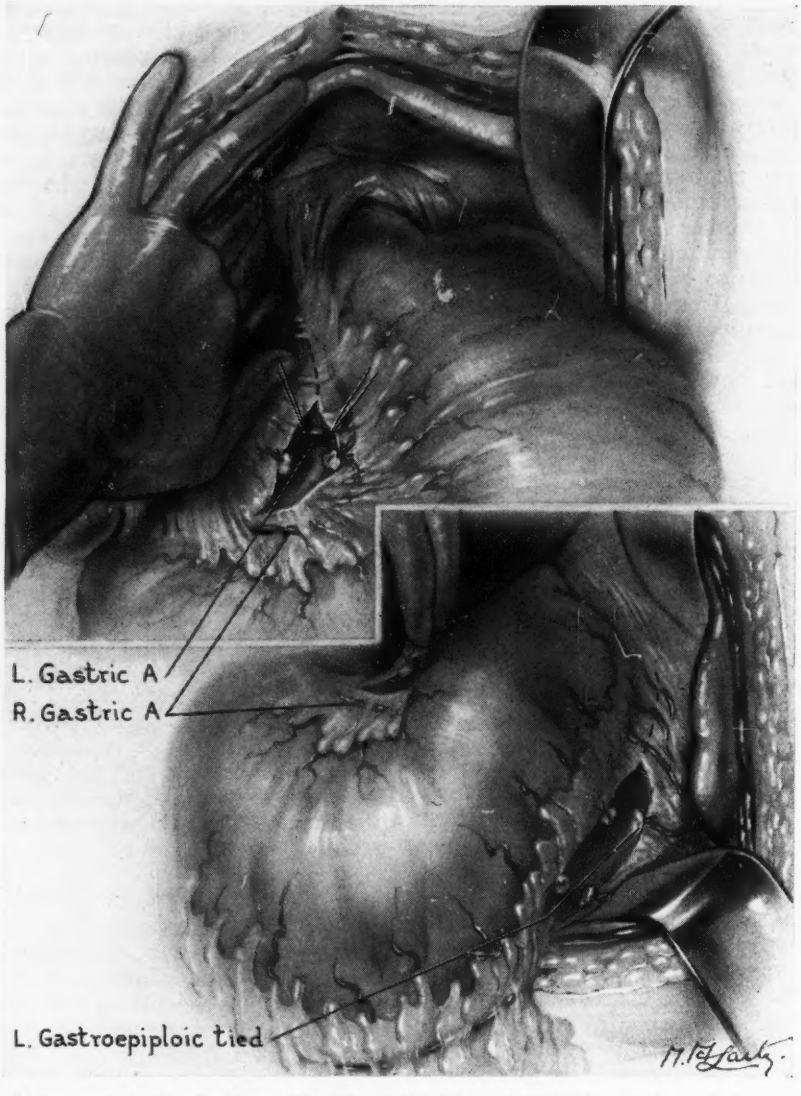


FIG. 35.—Left upper paramedian incision. The left gastric, left gastro-epiploic vessels, and the vasa brevia are divided, leaving a vascular arch along both curvatures.

Stage II.—With the patient in the left lateral position, and a sandbag under the chest, the whole of the right 6th rib from the neck to its cartilage is removed, and the chest entered through its bed (*Fig.* 36, inset). If after careful examination the growth seems removable, the lung is packed forward and the vena azygos major divided between ligatures (*Fig.* 36). The mediastinal pleura is then incised and just above and below the growth pieces of tape are passed round the gullet to be used as 'guy-ropes' (*Fig.* 37). The involved segment, together with any glands, is then slowly dissected free. Care must be taken to avoid opening the left pleura—a serious complication. There is no need to paralyse the phrenic nerve. The lower end of the œsophagus is gradually freed by retracting the diaphragm, dividing the branches of the vagi, and keeping it on the stretch with sponge-holders (*Fig.* 38). The part in the œsophageal hiatus is then freed with the index finger. A specially devised sickle-shaped retractor (*Fig.* 39) is now insinuated into the hiatus. This instrument not only retracts and stretches the hiatus with its tapering end, but holds the diaphragm and underlying liver out of the way. As soon as the cardia is drawn up through the hiatus, the peritoneum is opened and then severed all round the circumference. By steadily drawing on the cardia, the fundus and eventually the body of the stomach are brought up into the pleura (*Fig.* 40). Adhesions of varying strength will have formed in the interval since the first operation—they are separated. When the stomach is sufficiently mobilized so that the fundus reaches well above the

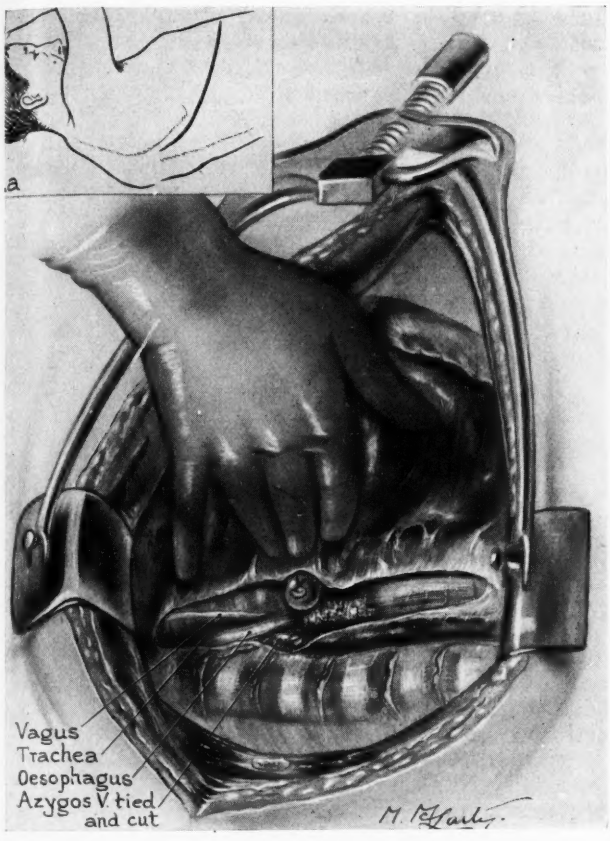


FIG. 36.—Right thoracotomy through bed of 6th rib. Vena azygos major has been divided and mediastinal pleura opened, showing growth at level of left bronchus.

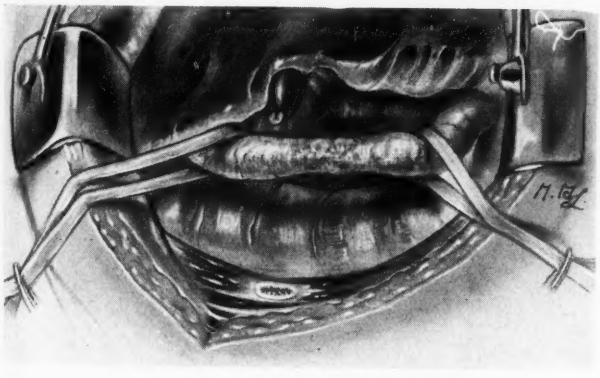


FIG. 37.—The œsophagus has been mobilized.

growth, the œsophagus with a wedge of cardia is severed and the gap sutured and invaginated. (If any enlarged glands have now become evident along the upper part of the lesser omentum it is probably safe to extend the excision to include part of the lesser curvature, and still leave the fundus viable—the vascularity of the stomach is remarkable.) The next step of the operation is to prepare a *gastric bed* on which the œsophagus will lie. The upper end of the stomach is fixed in the angle between the vertebral bodies and mediastinum. Five or six interrupted silk sutures are placed along each edge—posteriorly fixing the stomach to the anterior spinal ligaments and anteriorly to the anterior cut edge of mediastinal pleura (*Fig.* 41). The œsophagus is then laid

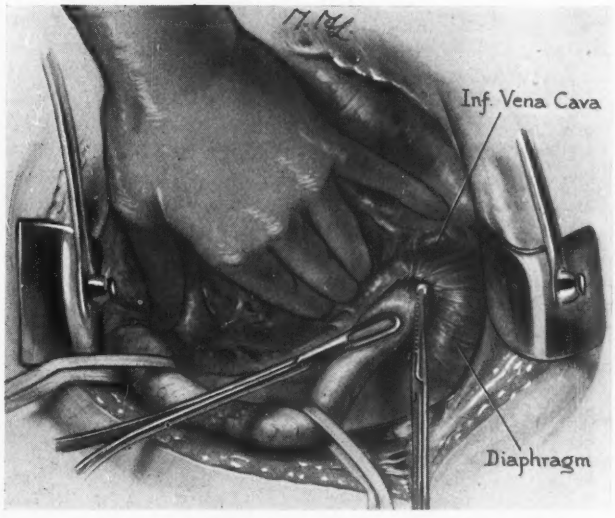


FIG. 38.—The lower end is gradually freed and drawn up by pledget dissection.

upon the stomach and the posterior layer of interrupted sutures is put in before cutting off the growth. A transverse incision is made in the stomach. Three points about this: (*a*) It should be on the short side—it can easily be lengthened, but once too long it will make for a faulty joint; (*b*) Any bleeding points should be tied before proceeding—the time will be amply repaid by a clean field and accurate suturing; (*c*) Keep a small sucker with a hooked point just inside the stomach incision. The through-and-through layer also should be done with a fine needle, fine silk, close interrupted sutures carefully including the œsophageal *mucosa* in every suture. As shown in the diagrams (*Fig.* 42), all knots are placed on the inside. The anterior seromuscular sutures are then placed. Finally, if it can be done easily, the stomach edges or omental fringes are folded over in front of the anastomosis and lightly sutured (*Fig.* 43). The enlarged hiatus does not need stitching up; it is only about the circumference of a wrist; three or four sutures are, however, placed between the stomach and its rim to prevent small gut passing through. 60,000 units of powdered penicillin is sprinkled around the anastomosis. A No. 14 catheter is placed alongside the anastomosis, with a second hole cut lower down to lie just inside the pleura. This is brought out through the 9th intercostal space laterally, to drain under water.

The chest wall is sutured in layers.

During the stitching up the anæsthetist endeavours to get the lung well expanded. Any air left is drawn out forthwith by suction to the catheter. Blood transfusion is given throughout the operation.

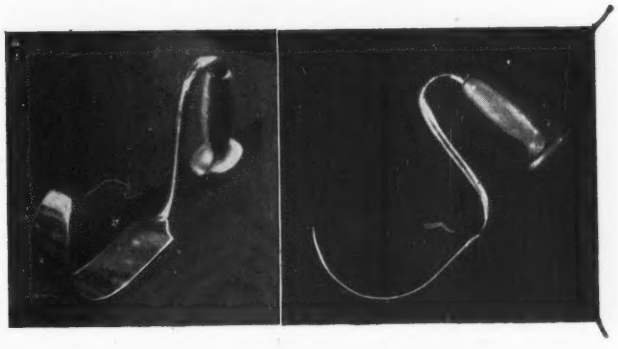


FIG. 39.—The special hiatus retractor.

FIG. 40.—The hiatus has been dilated and the fundus and body of stomach are being drawn up. Inset (*a*) shows line of section of cardia.

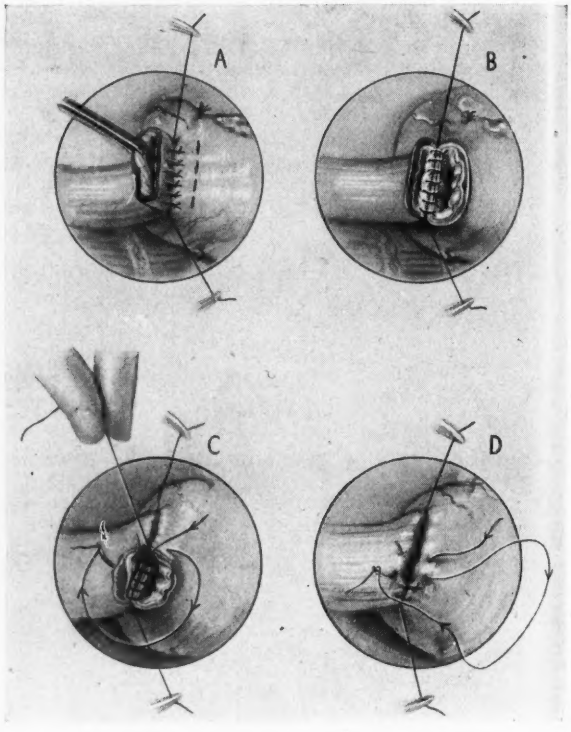


FIG. 42.—Details of the anastomosis. Note that the sutures are of fine interrupted silk. Each through-and-through suture includes the strong œsophageal mucosa which tends to retract out of sight. The knots are placed inside.

If there is an appreciable amount of bronchial secretion, a careful bronchoscopic cleansing is done before the patient leaves the table.

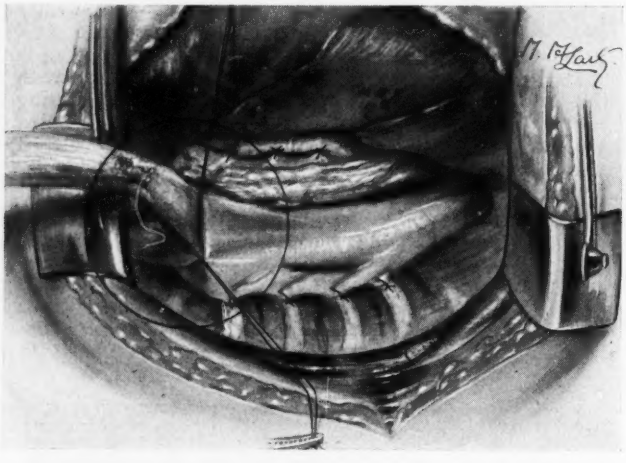


FIG. 41.—The making of the *gastric bed* and its fixation in the chest. The folded-back œsophagus is laid in position for the anastomosis.

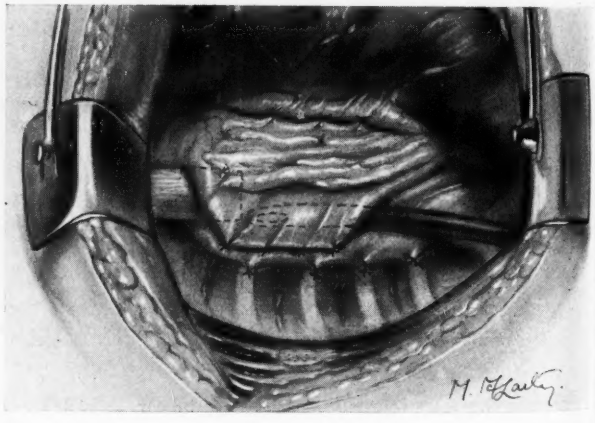


FIG. 43.—The stomach edge or an omental fringe is folded over in front of the completed anastomosis. The drainage catheter is fixed adjacent to the stoma.

Note: In these right-sided anastomoses, I have not crushed the phrenic nerve as the excursion of the diaphragm at the hiatus is small in contrast to that nearer the dome, which surrounds the stomach in left œsophagogastrostomies. The great advantage of a working diaphragm during the first few days after the operation is obvious, provided it does not, on inspection, pull on the actual suture line.

Post-operative Care.—Blood transfusion may be continued after the operation if necessary. In most cases, however, not more than 2 pints of blood in all will be required. After this the needle should be removed from the vein and nourishment given by the jejunostomy tube—a far safer way. Thus the danger of œdema of the lungs through too much

fluid, of phlebitis and lymphangitis, is entirely removed. For the first 12 hours or so 70 per cent oxygen by B.L.B. mask should be given. The patient is encouraged—and helped—to cough at frequent intervals. A bandage placed around the chest firmly, but not too tightly, is a great support. (Much harm has been done by the plausible contention that restrictive bandages cause respiratory complications after chest and upper abdominal operations. The one essential in all such cases is that the patient should keep his bronchi clear. This

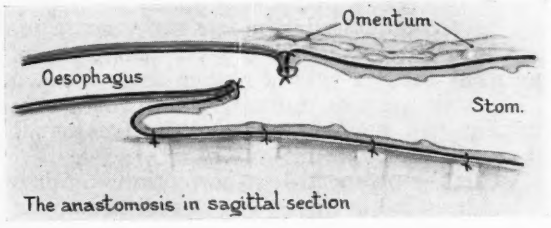


FIG. 44.—Sagittal section, looking from the right. Note the important layers—serous in stomach, mucosa in œsophagus.

he can do only by coughing. Coughing can only be done if the chest is firmly supported. The other great help to coughing is for the nurse to hold the sides of the chest really firmly whenever the patient needs to cough. If the bronchi are clear we need not worry much about the breathing; if they are not clear forced breathing only makes matters worse by aspirating the offending matter further down the bronchioles.)

A radiograph of the chest is taken every other morning. If any pneumothorax remains it is aspirated. On the third, seventh, and fourteenth days an ounce of barium emulsion is given to study the condition and emptying of the stomach by X rays. It takes a considerable time to regain its tonus after such an operation, particularly one where both vagi are severed. A Ryle's tube is passed daily and the stomach emptied and gently washed out with a 10-c.c. syringe. As the patient is fed by jejunostomy nothing is given by mouth for 10 days except ice to suck and an occasional toffee to keep the mouth clean. After this time, guided by the aspirations and the X rays, one can start feeds and steadily increase them, provided stomach emptying is satisfactory.

If during the early days œdema of the bases of the lungs develops, I have found concentrated intravenous serum of more value than anything else. In any case the blood-proteins should be estimated on the third post-operative day, as a critical fall may occur about this time. A culture from the intercostal catheter is taken after two days. If it is sterile the tube may be occluded by a spigot and strapped to the chest. I think it is prudent not to remove the tube for two weeks, however. If all goes well the patient should be eating a full soft diet by the end of three weeks, and getting up and about before that time.

Comments on the Operation.

1. Absence of tension on all anastomoses—indeed on all suture lines—is a basic requirement of surgery. In the operation described this is ensured by actually fixing the stomach to the chest wall and merely apposing the œsophageal stump to it. No tension sutures are placed in the œsophagus—they are not necessary in this operation and, were they so, would be a danger in its friable wall.

2. A small, but important technical detail: as the anastomosis is end-to-side, the layer likely to prove difficult from tension is the *anterior* œsophagoperitoneal. The corresponding posterior layer is merely between the œsophagus and the gastric bed it lies on. Therefore, so as to provide safe apposition in front, it is an advantage: (*a*) To pull the anterior stomach wall well up into the thorax—a little farther than the posterior, so that there is enough slack to place these sutures comfortably; (*b*) To use transverse mattress sutures for this layer.

3. *Infection* may occur in two ways: (*a*) By soiling during the operation; (*b*) By leakage after the operation. The utmost care must be taken by frequent suction, swabbing, and light clamping to prevent soiling. Leakage after the operation is entirely dependent on the technical security of the junction. Penicillin is worth using to counteract the soiling, but can hardly be expected to save the case with leakage.

4. *Time*: In an active, fit patient it is possible to do the abdominal and thoracic stages at the same operation, as the first stage need only take about half an hour. The main operation of resection with œsophagogastrostomy will take 2½ to 3½ hours. In poor-risk cases some time can be saved by not picking up and ligating every one of the numerous small vessels crossing or supplying the œsophagus, and compensating for the blood lost by an extra few ounces of transfusion. One hesitates to advocate so unsurgical a proposal, but it is certainly preferable to having to skimp any of the care and precision which the anastomosis itself demands. Another way to save a few minutes is to leave the forceps on the vessels of the chest wall during the operation. Instead of tying or coagulating, the handles are grouped together into three or four bunches and tied. At the end of the operation they are merely taken off—few of the bleeding points will start again.

5. *Damage to opposite pleura.* Several surgeons have referred rather casually to this accident and advised "covering the tear with a damp swab" or even "suturing the edges of the tear" before proceeding further. In fact, however, the sudden addition of the second pneumothorax, and that a valvular one, is the most serious trouble likely to occur during the whole operation. The increased respiratory embarrassment rapidly brings on circulatory failure. In one of the cases recorded actual ante-mortem thrombi formed in the right auricle. If a tear should occur certainly the best way to deal with it is immediate plugging with a wet swab and reliance on the anæsthetist's skill to carry out controlled respiration exclusively for the rest of the operation. The plugging by itself is capricious and is apt suddenly to allow access of more air, which cannot be expressed again. Any attempt at suture of the thin membrane is to make matters worse, quite apart from the fact that usually the growth cannot yet be lifted from its bed, and so give good access. Probably the best course, where the growth appears adherent to the opposite pleura, is merely

to dissect all round and carefully postpone further manipulation on the deep aspect. When the distal end of the œsophagus has been cut it can be lifted well up and the growth finally freed. At this stage, should a tear occur, it can be immediately plugged and the plug need not now be disturbed till the moment the chest is finally closed and both pleuræ exhausted.

RETROSPECT AND PROSPECT

" Fear of the pleura will in a few years pass into the limbo of forgotten things, there to keep company with the fear of the peritoneum which for so long haunted the minds of surgeons." These words were written, not in 1943, but in 1903, by Gosset. He, moreover, went on to state that not only the transpleural transphrenic œsophagogastrostomy worked out experimentally by him could be carried out by that route, but also total gastrectomy. One is tempted to dismiss such a statement as an over-confident and hasty prophecy based, as it was, on three bodies and a dog ! It was all very well to belittle the dangers of transpleural operations, at a time when those dangers, physiological and infective, still meant a mortality of nearly 100 per cent. It is not surprising that much of the next 40 years was spent in devising ways of circumventing the dangers rather than facing them. Since surgeons returned to a frontal attack, progress has been rapid, and Gosset lived to see his prophecy vindicated before his death in 1944. The operative mortality in all the cases of œsophagectomy which Ochsner and De Bakey could collect up to 1940—a total of 191, was 72 per cent. Since then it has steadily fallen, in spite of the fact that an increasing number of anastomoses have been carried out, making the operation longer and more difficult. Garlock, in 1944, reported he had operated on 60 cases, with a mortality of 48 per cent. In 45 of these an anastomosis was done. Recently he reports that his mortality has come down to about one in three (Garlock, 1945). Sweet (1945) reports 90 cases of resection with œsophagogastrostomy at Massachusetts General Hospital with only 16 deaths (18 per cent); their total mortality rate for all the transpleural resections, both œsophagogastrostomies and total gastrectomies, was 21 per cent. Phemister (1945) has operated on 22 cases, with 8 deaths. It thus looks as if the operative mortality, in the hands of surgeons who are both adept at abdominal surgery and also used to working in the thorax, is going to settle well below 40 per cent. As for long-term results it is still early to judge, as nearly all the large series have been completed so recently, although we do know that the great majority have recurred within two years. Nevertheless the number of long survivors is gradually mounting. No one has yet had a patient live as long as Torek's original case—thirteen years. Garlock (1945), out of 76 resections, has 24 alive and well, varying from ten years to one month. Out of his 36 patients with squamous carcinoma 10 are alive and well, 4 of them over five years, 2 two and a half years, 2 one year. Of his 40 resections of the cardia (adenocarcinoma), all with anastomosis, 14 are alive and well, the period ranging from five and a half years down, the majority between two and three years. Sweet (1945) tells me he has the following survivors out of a total of 84 operated on: 1 over five years, 1 over four years, 7 over two years. Noland Carter (1945), out of 8 successful resections, only had 1 live over two years. Phemister (1945) states that of his 14 operative successes, only 3 have lived over two years. His well-known first case (1938) is still alive and well. The other 2 lived three years, both dying of recurrence. Out of a total of 172 cases operated on in three American centres in the last few years with an operative mortality of 29 per cent there are 7 cases alive and well over five years, 21 over two years. As rather more than half the cases have been done in the last two years, a rough corrected figure would be a 5-year survival-rate of 9 per cent and a 2-year of 25 per cent.

We have come to realize that the Torek type of operation will possibly prolong the patient's life, and certainly prolong his misery.

As for the prospect, it is not entirely a fair one. We had been led to hope that the problem of cancer of the œsophagus was essentially a technical one. But as that gets solved, disquieting evidence is accumulating that this lesion is, in the main, of rather a high malignancy. Degree of malignancy, to the patient, is the length of time the disease takes to kill him; to the pathologist it is an opinion based on post-mortem findings and the appearance of the cells. For the surgeon, it may be defined as the liability to recurrence after apparently adequate removal. This is the practical criterion, and in a few years it will decide the long debate as to whether cancer of the œsophagus is of high or of low malignancy. In the meantime 2300 people in England and Wales develop cancer of the œsophagus every year. Our aim must be radical operation in more of the early cases and in fewer of the late ones. The hope of discovering some early symptom which would bring the cases to light before the obstructive stage is unlikely to materialize. In the minority of patients where pre-obstructive symptoms do occur (epigastric discomfort, retrosternal pain, a sore feeling in the back, cough) these are not clamant enough to take them to the doctor and not characteristic enough to suggest the diagnosis even if they did. We therefore have to fall back on dysphagia as *the* symptom. Is it too much to hope that before long the public will be taught that any disturbance of swallowing must mean seeing the doctor about it, that doctors will assume all such cases over 40 years of age to be due to cancer unless obviously due to something else, and that physicians and surgeons will insist that such growth is excluded only when both radiography *and œsophagoscopy* are negative? The early case means less sepsis, less malnutrition, an easier and quicker operation. (The late cases, doubtfully operable, will probably come to be treated by a by-pass operation, using fundus of stomach or jejunum according to the circumstances, perhaps combining the procedure with direct irradiation through the wound.) Early diagnosis should thus be rewarded by a reasonable operative mortality, good relief of symptoms, and at any rate a fair number of 5-year cures. It is disappointing that, for the moment, the outlook is not brighter. For no field in surgery presented more dangers and difficulties; in none was the challenge taken up

with more persistent endeavour in the face of repeated failures.

SUMMARY

1. A brief account of how the bold early experiments in œsophageal surgery were followed by decades spent in trying to circumvent rather than face the dangers, and recently by a return to straightforward resection with anastomosis.

2. An account of 7 personal cases of œsophagectomy, with 5 recoveries.

3. The principles of œsophageal resection with anastomosis for cancer of the lower end, and the difficulties of applying similar methods to cancers higher up.

4. An account is given of a new operation of resection with immediate anastomosis for cancer in the middle third. After first mobilizing the stomach by laparotomy, a *right* transpleural œsophagectomy is performed, the stomach being brought up through the dilated hiatus, fixed at any required level in the right pleura, and an end-to-side œsophagogastrostomy performed.

5. A review of what has been achieved and how it might be improved upon.

I would like to thank my anæsthetists, particularly Dr. Faux and Dr. Parry Brown, for their enthusiastic and skilful help, and their equanimity; also my house surgeons and ward sisters for their unremitting post-operative care. *Cases* 4 and 6 were shown at the Royal Society of Medicine, and I am indebted to the Honorary Editor of the *Proceedings* for permission to include them here.

REFERENCES

ADAMS, W. E., ESCUDERO, L., ARONSOHN, H. G., and SHAW, M. M. (1938), *J. thorac., Surg.*, **7**, 605.
— — and PHEMISTER, D. B. (1938), *Ibid.*, **7**, 621.
ALLISON, P. R. (1942), *Brit. J. Surg.*, **30**, 132.
BILLROTH, T. (1871), *Arch. klin. Chir.*, **13**, 65.
BIONDI, D. (1895), *Policlinico* (suppl.), sect. i, 964.
BIRCHER, E. (1918), *Cor. Bl. schweiz. Arzteztg.*, **48**, 467.
BIRD, CLARENCE (1939), *Surgery*, **6**, 772.
BRODERS, A. C., and VINSON, P. P. (1928), *Arch. Otolaryng., Chicago*, **8**, 79.
CARTER, NOLAND (1945), letter to author.
— — STEVENSON, JEAN, and ABBOTT, O. A. (1941), *J. thorac. Surg.*, **10**, 446.
CHURCHILL, E. D., and SWEET, R. H. (1942), *Ann. Surg.*, **115**, 897.
CZERNY, V. (1877), *Zbl. Chir.*, **4**, 433.
DENK, W. (1913), *Ibid.*, **40**, 1065.
EDWARDS, A. TUDOR (1935), *Proc. Roy. Soc. Med.*, **29**, 188.
EGGERS, CARL (1933), *J. thorac. Surg.*, **2**, 229.
FAURE, J. L., and DEMOULIN, A. (1903), *Bull. Mém. Soc. Chir.*, **29**, 122.
FRANKLIN, R. H. (1942), *Brit. J. Surg.*, **30**, 141.
GARLOCK, J. H. (1938), *Surg. Gynec. Obstet.*, **66**, 534.
— — (1940), *Ibid.*, **70**, 556.
— — (1944), *Ibid.*, **78**, 23.
— — (1945), letter to author.
— — et al. (1944), *J. thorac. Surg.*, **13**, 415.
GOHRBANDT, E. (1927), *Zbl. Chir.*, **54**, 26.
GOSSET, A. (1903), *Rev. Chir., Paris.*, **28**, 694.
GUISEZ, J. (1931), *Bull. Soc. méd. Hôp. Paris*, **47**, 908.
VON HACKER, VICTOR (1891), *Zbl. Chir.*, 18, 121.
INGEBRIGTSEN, R. (1933), *Acta chir. Scand.*, **73**, 43.
JACKSON, CHEVALIER (1925), *Amer. J. med. Sci.*, 169, 625.
KIDD, H. A. (1943), *Brit. J. Surg.*, **30**, 340.
KING, E. S. J. (1936), *Ibid.*, **23**, 521.
KIRSCHNER, M. (1920), *Arch. klin. Chir.*, **114**, 606.
KÜMMEL, H. A. P. Fr. (1910), *Dtsch. med. Wschr.*, **36**, 1886.
LEWIS, IVOR (1945), *Proc. Roy. Soc. Med.*, **38**, 482.
LILIENTHAL, HOWARD (1921), *Ann. Surg.*, **74**, 259.
MEYER, WILLY (1912), *Surg. Gynec. Obstet.*, **15**, 639.
VON MIKULICZ, J. (1886), *Progr. med. Wschr.*, **11**, 93.
MUIR, E. G. (1936), *Lancet*, **2**, 75.
OCHSNER, A., and DE BAKEY (1941), *J. thorac. Surg.*, **10**, 401.
OGILVIE, W. H. (1938), *Brit. J. Surg.*, **26**, 10.
OHSAWA, T. (1933), *Arch. jap. Chir.*, **10**, 605.
O'SHAUGHNESSY, L., and RAVEN, R. W. (1934), *Brit. J. Surg.*, **22**, 365.
PHEMISTER, D. B. (1945), letter to author.
SAUERBRUCH, F. (1905), *Beitr. klin. Chir.*, **46**, 405.
STEEL, G. H. (1943), *Lancet*, **2**, 797.
SWEET, R. H. (1944), *J. thorac. Surg.*, **13**, 423.
TAYLOR, HERMON (1945), *Brit. J. Surg.*, **32**, 394.
THOMPSON, V. C. (1945), *Ibid.*, **32**, 377.
TOREK, F. (1913), *Jour. Amer. med. Ass.*, **60**, 1533.
TURNER, G. GREY (1933), *Lancet*, **2**, 1315.
VINSON, P. P. (1933), *Northw. Med., Seattle*, **32**, 320.
VOELCKER, F. (1908), *Gesellsch. Chir.*, **37**, 126.
WOOKEY, HAROLD (1940), *Brit. J. Surg.*, **27**, 696.
WRIGHT, DICKSON (1945), *Proc. Roy. Soc. Med.*, **38**, 131.
ZAAIJER, J. H. (1913), *Beitr. klin. Chir.*, **83**, 419.

CHRONIC OSTEOMYELITIS, THE SEQUEL TO A GUNSHOT WOUND

BY GEORGE PERKINS, *M.C.*, LONDON

STARTING as a localized acute inflammation, osteomyelitis due to a penetrating wound pursues one of five courses :—

a. The inflammation may die down within a reasonable time and never again trouble the patient. Probably this is the most frequent outcome. The body, by its defences, aided medically by drugs that inhibit the growth of organisms and surgically by drainage, smothers the infection.

b. The acute inflammation may continue for a long time, and from its very chronicity acquire the appellation of chronic osteomyelitis. This, however, is not what we generally mean by chronic osteomyelitis, and it is better to distinguish it under the separate title of *persistent acute osteomyelitis*.

c. The acute inflammation may subside, leaving behind a sinus which extends down into the interior of the bone.

d. The acute inflammation may die down and the wound heal; but later, after an interval of months or years, the acute inflammation recurs. We refer to these recurrent eruptions as *flares*.

e. The patient may have a chronic sinus and also be subject to recurrent attacks of acute inflammation in the bone.

The problem, therefore, resolves itself into treating one of four conditions, namely: (1) Persistent acute osteomyelitis; (2) A sinus; (3) Recurrent acute osteomyelitis (a flare); and (4) A sinus with flares.

PERSISTENT ACUTE OSTEOMYELITIS

This is a medical and not a surgical problem. The inflammation persists because the body is unable to kill the attacking organisms or to prevent their multiplying, and surgery cannot influence the quality of the natural defences of the body. We surgeons want assistance from the pathologists and the chemotherapeutists. Let the pathologists tell us how to bolster up the natural defences, for it is by these defences that the infection is ultimately conquered; and let the chemotherapeutists give us a drug that taken by the mouth will penetrate via the blood-stream into the utmost recesses of bone. Penicillin is such a drug, but there is a limit to the time that it can be used because the patient revolts against being persistently jabbed with a needle.

It is true that surgery is of use in acute inflammation, by affording an exit to pent-up pus, as in the opening of an abscess, and by excising *in toto* an inflamed area, as in appendicectomy. And these successes have tended to make the surgeon forget his limitations. In osteomyelitis due to a penetrating wound there is nearly always adequate drainage, and surgery therefore is not required to give an exit to pus. Nor can we hope to excise the whole of the acutely inflamed bone without grossly infecting the surrounding tissues, the defences of which are known to be subnormal. We are forced to the conclusion that there is no surgical treatment for persistent acute inflammation of bone.

However, although the inflammation does die down at last, it may by its prolongation endanger the life of the patient. Moreover, other disabilities may be present that would render the limb of little use even when the osteomyelitis had subsided; for example, an ununited fracture, an unsuturable nerve lesion, stiff deformed joints, damage to main blood-vessels, wide destruction of skin. Therefore, in persistent acute osteomyelitis, amputation of the limb is often advisable, either to save life or because an artificial limb will be of more use to the patient than his own crippled leg.

A SINUS

The acute inflammation of the bone may subside, leaving behind a sinus. A sinus is a nuisance because it condemns the patient to wear a dressing to protect his clothing, and because the smell from the discharge (particularly if the wound is secondarily infected by *B. proteus*) is often offensive; and patients often clamour for treatment in the belief that a surgeon can easily get a sinus to heal. Sometimes he can; more often he cannot. A sinus indicates (*a*) the presence of a foreign body or sequestrum, which the patient is endeavouring to wash out of his body, or (*b*) the continuation of a mild chronic infection of the bone. And it is often difficult for the surgeon to decide which of these two conditions confronts him. A radiograph may give valuable information, as it reveals metallic foreign bodies and often sequestra. It is not, however, conclusive, for the foreign body may not be opaque (an unabsorbable suture, for example) and not all sequestra are denser than the surrounding bone.

As a rule, a sinus heals after the removal of a foreign body or sequestrum; and whenever the radiograph reveals either, the surgeon should operate. When the radiograph reveals neither, it is justifiable to operate once, and once only; for if the sinus recurs (as so often happens) further operations are unlikely to be any more successful.

It is important for the surgeon to decide why he is operating, because the type of operation differs in the two cases.

Operation when a Sequestrum or Foreign Body is Present.—The aim of the operation is the removal of the sequestrum or foreign body. A probe is inserted into the sinus and the surgeon cuts straight down (anatomy permitting) on to the point of the probe. If this has entered bone, a small coffin-shaped piece of cortex is removed and discarded, revealing a cavity within which the sequestrum is lying. The sequestrum is picked out and the wound is lightly sewn up without drainage. No attempt is made to excise the track or to obliterate the bone cavity. Should the wound later show signs of inflammation the stitches are removed and the wound allowed to gape. The object of the operation is the removal of the cause of the irritation, and if this is achieved the sinus closes.

The question arises—at what time after the onset of the osteomyelitis should one remove sequestra? I believe this should be determined not by the length of time that has elapsed but by the cessation of acute inflammation in the bone. But how are we to know whether the bone is still acutely inflamed? There are so few signs of active inflammation of bone. The radiograph does not help, and provided the products of inflammation are not under tension there is no pain. In fact, the only clinical sign is tenderness of the bone. However, with osteomyelitis due to a penetrating wound there is always infection of the soft tissues as well as infection of the bone; and inflammation of the soft tissues can be detected clinically. And we may assume that when the defences of the body have overcome the infection of the soft tissues they have simultaneously overcome the active infection in the bone. If the soft tissues are still inflamed, so is the bone; if the soft tissues are no longer inflamed we may assume that active inflammation has also subsided in the bone. In my judgement, sequestrectomy should be deferred until the soft tissues around the sinus are free of heat, redness, swelling, and tenderness. As soon as the inflammation of the soft parts has subsided sequestrectomy can be safely undertaken. One need have no fear that the sequestrum will not be loose, because sequestra are already detached by the time they are disclosed by radiographs.

Operation when there is No Sequestrum or Foreign Body.—In this case the object of the operation is the removal of all infected bone, the assumption being that the sinus exists to give an exit to the products of the continuing inflammation. The plan of operation is entirely different from that of sequestrectomy.

The sinus track is excised and as much of the surrounding fibrous tissue removed as is safe, having regard to the presence of main nerves and vessels. A large extent of bone is exposed subperiosteally, and up to a half of the circumference of the cortex is chiselled away piecemeal until healthy bleeding bone is reached. Sometimes the whole diameter of the bone is permeated with chronic inflammatory tissue; if this is so, the operation will probably fail, since the aim of the operation—the complete removal of all infected bone—cannot be attained. Care must be taken not to fracture the bone, and the limb should be well supported on sandbags during the operation to minimize the risk. The walls of any cavity should be removed, for unless the soft tissues can fall in and obliterate all dead spaces the operation is unlikely to succeed because the void will be filled with blood-clot which acts as an incubation chamber for the growth of organisms, whereby the infection is perpetuated. The operation entails hard work and much chiselling.

So far, so good. The surgeon has succeeded, as he hopes, in removing all the infected bone. However, his task is only half done; he now has to prevent the bone from getting reinfected either by its own organisms, some of which of necessity remain in the wound, or by new organisms introduced from outside.

In the old days reinfection was taken for granted and an immediate acute inflammation of the bone was assumed to be inevitable; and in order to prevent further necrosis from this new bout of inflammation free drainage from the bone was considered imperative. Accordingly, the wound was lightly packed with gauze soaked in paraffin, and this was renewed every few days. The result was that a new infection was introduced and the operation failed to cure the sinus. The recent war has changed this procedure; for it has taught us that it is well-nigh impossible to prevent exposed tissues from becoming infected, however carefully the dressings are done; it has also given us an antiseptic harmless to the tissues. Modern treatment is based not on the inevitability of reinfection, but on the vital necessity for avoiding it.

After the removal of the dead bone, therefore, the wound is sprayed with penicillin, care being taken not to overlook small crevices and recesses, and the wound is sewn up. Some surgeons leave tubes reaching down to the bottom of the wound through which penicillin in solution can be squirted from time to time. This does not appeal to me, as I cannot believe the fluid can circulate freely and permeate the whole wound, as it can when injected into one of the natural cavities of the body. On the other hand, any channel of communication between the outer world and the depth of the wound is an invitation to organisms to enter.

This procedure—thorough spraying of the walls with penicillin, followed by immediate suture of the wound—is feasible when the bone is lying at some depth from the surface. But when the bone is subcutaneous the wound cannot always be closed for lack of healthy skin. It is futile to try and obliterate a gap by sewing the edges of the skin under tension; the suture line invariably breaks down. To replace lost skin, skin must be imported. Three methods are under trial: (*a*) Covering the raw area with a Thiersch graft; (*b*) Raising at a previous operation lateral skin-flaps ready to be swung across the gap; and (*c*) Preparing beforehand a full-thickness skin-graft and transplanting one end of it some weeks before the bone operation is undertaken.

It sometimes happens that the radiograph shows a foreign body in the soft parts and old osteomyelitis, and the surgeon is not sure whether the sinus is caused by the foreign body or by smouldering inflammation in the bone, and in consequence is undecided which type of operation to perform—whether a simple removal of the foreign body or a resection of the diseased bone. In these circumstances useful information is sometimes obtained by X-raying the area after the injection of lipiodol into the sinus. When the opaque track leads towards the foreign body it is a safe assumption that the foreign body is the cause of the sinus, and the simple operation is indicated; when the track leads into the bone the bone should be excised.

These two operations—sequestrectomy and bone excision—are both designed to get rid of a sinus. And I have said that if the sinus recurs after one bone excision, no further operation should be attempted in the hopes of getting the sinus to heal. There is, however, one exception to the rule that a sinus should not be operated upon after a bone excision has failed: another operation *is* justified if the discharge from the sinus stinks. A spring-cleaning operation, at which as much infected tissue as possible is removed, often gets rid of the secondary infection and therefore of the smell. But the patient should be made to understand that the operation aims only at getting rid of the smell; otherwise he will be disappointed when the sinus fails to heal.

RECURRENT ACUTE OSTEOMYELITIS (A FLARE)

These flares, although associated with local signs of inflammation and often with intense pain, are peculiar in that they are not accompanied by severe or lasting toxæmia. The patient's temperature is raised and he may feel ill; but this phase passes off quickly, and within a few days his health is restored. In this respect a flare is not unlike a bout of malaria.

There is no accounting for these flares, and no known method of avoiding them. A patient may not have had any symptoms for years—perhaps 20—then, after a blow or excessive muscular exertion, or sometimes for no obvious reason, the wound flares. The rapidity and ease with which these flares are overcome show that the body has a strong defence, but seemingly the defence is not strong enough to prevent an attack, although capable of smothering it when it occurs. Immunizing the patient with vaccines has not met with any success; indeed, an interesting fact is that once the patient starts having flares he may have several in quick succession in spite of not having had any trouble for years previously.

The inflammation may or may not be confined to the bone. Clinically, the skin, the deep tissues around the bone, or the bone itself, may appear to be the principle (or sole) site of the inflammation. Of particular interest is the subcuticular inflammation

that spreads far up and down the limb and resembles an erysipelas. An attack of erysipelas of this nature is a good omen, since it seems to confer an effective immunity lasting some time.

Treatment consists of rest, and the patient should be kept in bed. Locally, hot poultices are soothing. Surgery is not indicated unless an abscess forms. An abscess should, of course, be opened, but there is no urgency. The longer the abscess can be left, the nearer it approaches the surface, and the smaller need be the opening. Meanwhile, the patient is receiving self-immunization. It is sufficient to give an exit to the pus through a small incision, and to leave the wound open; it is not necessary (or advisable) to establish prolonged drainage. As a rule, the wound heals within a week or two, and the patient's condition is then much what it was before the flare. Even when an abscess arises within the bone, the bone rarely needs to be touched because cloacæ allow the pus to escape from the bone. Only exceptionally, when a high temperature and severe pain persist, is exploration of the bone called for.

A SINUS WITH RECURRENT FLARES

These cases as a rule defy treatment. The sinus indicates a persistent grumbling inflammation, and the flares indicate that the bone is riddled with organisms that are potentially active. Operation rarely does any good, particularly when the end of a shaft is involved, where for anatomical reasons an adequate removal of diseased bone is not feasible.

Most of these patients have undergone many extensive bone operations without any benefit, each one invaliding them for many months. Excluding an operation on the bone, there are two courses open to the patient: one, to accept his lot and to be resigned to periodic flares which will keep him from work for several weeks once or twice a year; and the other, to lose his limb. Many a pensioner of the last war is to-day thankful that he was at last persuaded to have his leg amputated.

Under penicillin it is usually safe to do a definitive amputation at a seat of election, in spite of infection in the bone lower down.

It remains to be stated that penicillin has not in my experience been of any benefit in preventing flares or in healing sinuses. Patients with chronic osteomyelitis willingly submit themselves to a trial of this treatment, and such is the faith of human nature that most of them declare that they have derived benefit from penicillin, sometimes even after the first injection. But to a sceptical observer it is difficult to see any change in the chronic osteomyelitis.

As surgeons, we want to know what surgery has to offer in the treatment of chronic osteomyelitis. Surgery is useful:—

1. To remove a sequestrum.
2. To excise a whole area of diseased bone, if that is possible.
3. To get rid of an intolerable smell.
4. To open an abscess.

In other words, the four indications for surgery are a sequestrum, a sinus, a swelling, and a smell.

A STUDY OF THE FATE OF NERVE HOMOGRAFTS IN MAN*

By R. BARNES, P. BACSICH, G. M. WYBURN, and A. S. KERR.*

In 1920 the Medical Research Council reported "nerve-grafts should only be adopted as a substitute for end-to-end suture in those very rare instances where it is absolutely impossible to bring about direct approximation". Interest in nerve-grafting was revived in 1932 when Ballance and Duel (1932), recorded the successful repair of facial-nerve injuries by autografts.

A fair proportion of nerve homografts are successful in cats (Bentley and Hill, 1936) and rabbits (Sanders and Young, 1942, and Bacsich and Wyburn, 1945, unpublished results), while Bentley and Hill (1940), after the repair of the external popliteal nerve of monkeys by a 3-in. nerve homograft, were able to elicit a satisfactory motor response on electrical stimulation of the nerve, and in some cases observed large numbers of nerve-fibres throughout the length of the homograft. Moreover, in man, regenerating nerve-fibres may penetrate some distance into, or even traverse the entire length of, the graft, and there appears in most cases to be a satisfactory vascularization of the graft. Recent accounts (Sanders, 1942; Seddon and Holmes, 1944; Spurling, Lyons, Whitcomb, and Woodhall, 1945) stress the unqualified failure of the nerve homograft in man. The present report on the results of 8 cases of human nerve homografts once more confirms what can now be regarded as the normal expectation of the complete failure of this method of repair of gaps in the large nerves of the limbs.

Therefore, although from the standpoint of the surgeon the nerve homograft should be regarded as an incontrovertible failure, the experimentalist is tempted to further investigation by the tantalizing histological picture of partial success. The problem of the nerve homograft is not an isolated one, but part of the wider question of tissue reaction to grafts in general. The purpose of this account is therefore twofold. First, to add if need be further evidence to discourage, for the present at any rate, the use of nerve homografts for the repair of the large nerves of the limbs in man; and secondly, to study the late condition of nerve homografts in the hope that the accumulation of such knowledge will aid in the understanding of factors which determine its inevitable failure—a necessary preliminary to attempts to combat or eliminate such adverse factors. "Es muss unsere Aufgabe sein, den Grunden für das Misslingen der Operation nachzugehen und die bedingungen des Erfolges klarzustellen."—Eden (1919).

* From the Departments of Surgery and Anatomy, Glasgow University, and Winwick Emergency Hospital.

MATERIAL AND METHODS

There are 8 cases of nerve homografts involving the large nerves of the limbs. In 3 of these the resected grafts were sectioned both transversely and longitudinally at 10μ. Three separate sets of transverse sections were collected from both the central and peripheral ends of each block—one stained with a modified protargol method, one with hæmalum and eosin, and the other with a modified Weigert stain. Two series were made of the longitudinal sections—one stained with protargol and the other with hæmalum and eosin. Occasional transverse and longitudinal sections (5μ) were stained by Mallory's or Pasini's triple stain. Clinical histories of these 3 cases are given in detail. The main features of the remaining 5 cases, in which there was only a limited histological study of the grafts, are summarized in *Table I.*

FIG. 45.—*Case* 1. Transverse section of central stump. Numerous medium-sized bundles, some of which are rather sparsely populated. Marked interfascicular fibrosis. (Modified protargol method.) (× 12.)

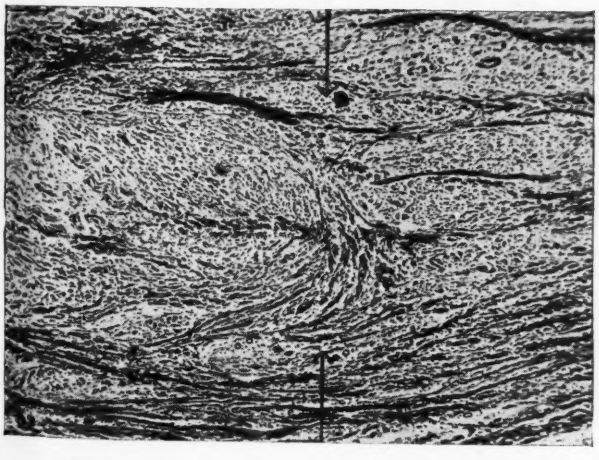


FIG. 46.—*Case* 1. Junction (marked by arrows) of central stump (left side) and graft (right side). Nerve-fibres cross the suture line. There is considerable irregularity and criss-crossing at junction. (Modified protargol method.) (× 42.)

Case 1.—A soldier, R. G. R., aged 28 years, sustained an adduction injury to his left knee, due to a motor cycle accident on June 26, 1941. The lateral ligament of the knee was ruptured and there was a severe traction injury of the lateral popliteal nerve.

On Aug. 8, 1941, he was admitted to Winwick Emergency Hospital with a complete lesion of the lateral popliteal nerve. At operation on Sept. 1, the nerve was found to be involved in a mass of scar tissue at the level of the head of the fibula. Successive sections were made of the proximal end of the nerve to a point 10 cm. above the head of the fibula, but even at that level most of the nerve consisted of fibrous tissue, apart from a few bundles running to the ramus communicans fibularis. In view of these findings it was obvious that an end-to-end suture could not be performed with any hope of success, and it was decided to insert a homograft at a second operation.

On Feb. 21, 1942, 240 days after injury, the nerve was re-explored and a further 7 cm. of the central stump was resected before healthy nerve-bundles were encountered. There was now a gap of 18 cm. between the two ends of the nerve. This gap was bridged by a homograft removed from the external popliteal nerve of a patient who had died four hours previously. The suture was performed with stainless steel wire of a diameter of 0·0018 in. The graft was of smaller diameter than the recipient nerve and only about 75 per cent of the nerve-bundles at the proximal suture line were in contact with the graft. The blood group of the donor was unfortunately not determined. The post-operative convalescence was uneventful and the patient was discharged three weeks later, wearing a toe-raising spring.

On Feb. 9, 1943, he reported for review. A firm cord was palpable behind the knee in the line of the graft; pressure over it produced no tingling in the foot. There was no evidence of any sensory or motor recovery.

On Feb. 11, 355 days after insertion, the graft was re-explored under local anæsthesia. The graft was identified without difficulty, it was much firmer than at the time of insertion and felt like tendon. There was a firm neuroma at the proximal suture line. The graft was more adherent to the surrounding soft tissues than was the central stump. There was no sensory or motor response on stimulating the graft with a faradic current, but a powerful sensory response was obtained at the proximal suture line, which could easily be identified by the presence of the wire sutures. The entire graft, with a portion of central and peripheral stumps, was excised.

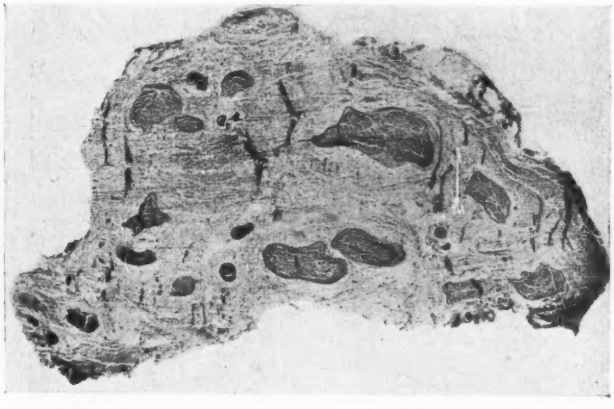


FIG. 47.—*Case* 1. Transverse section of proximal end of graft. There are about 12 fair-sized bundles, most of them fairly well populated. (Modified protargol method.) (× 12.)

HISTOLOGICAL EXAMINATION.—

Central Stump.—There are about twelve medium-sized bundles and one or two smaller ones (*Fig.* 45). The bundles, some of which are rather sparsely populated,

contain myelinated and non-myelinated nerve-fibres. The Weigert stained sections show considerable numbers of thinly myelinated fibres. There is marked interfascicular fibrosis.

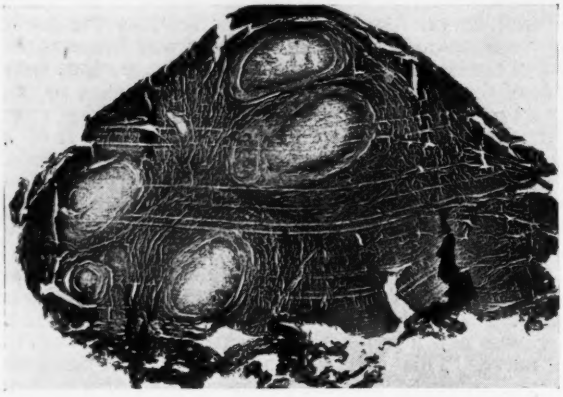


FIG. 48.—*Case* 1. Transverse section of graft below level of nerve-fibres. Varying degrees of necrosis in fascicles surrounded by mass of dense fibrous tissue. (Hæmalum and eosin.). (× 15.)

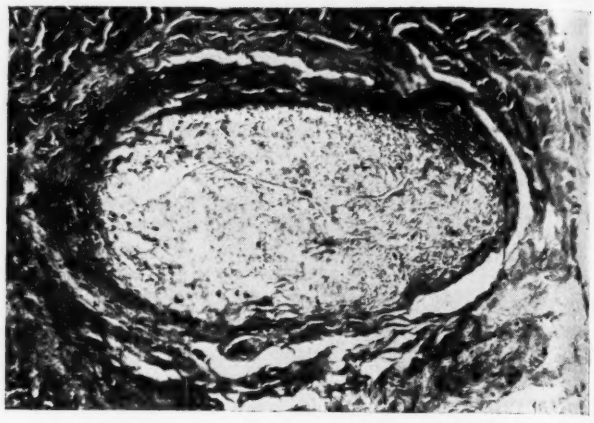


FIG. 49.—*Case* 1. Transverse section of graft at a slightly lower level than *Fig.* 48. Well-preserved perineurium. Complete necrosis of intrafascicular contents. (Hæmalum and eosin.) (× 95.)

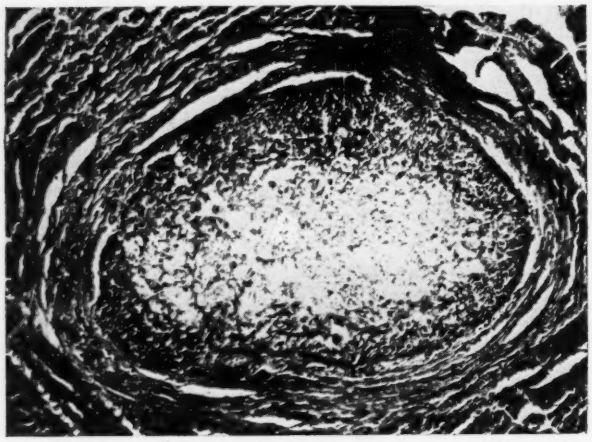


FIG. 50.—*Case* 1. Transverse section of graft. Early fibrosis. Mass of necrotic tissue in centre of a fascicle is enclosed by proliferating cellular fibrous tissue. (Hæmalum and eosin.) (× 95.)

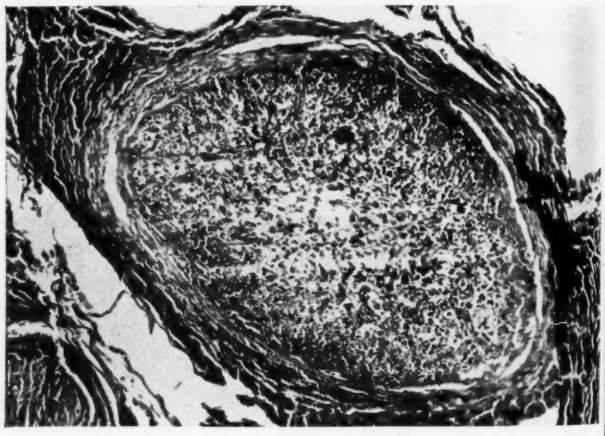


FIG. 51.—*Case* 1. Transverse section of graft. Late fibrosis. Necrotic mass inside fascicle is more or less completely replaced by cellular fibrous tissue. (Hæmalum and eosin.) (× 95.)

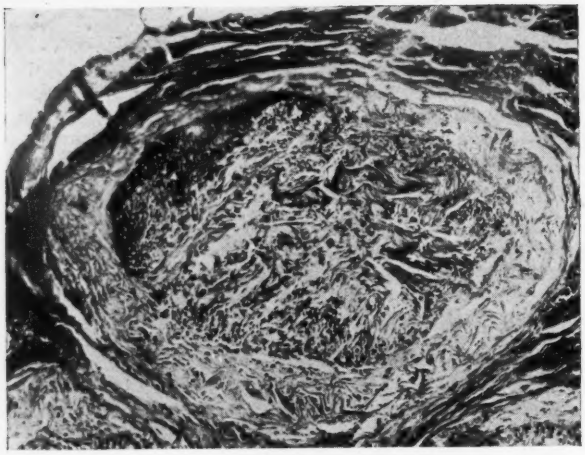


FIG. 52.—*Case* 1. Transverse section of graft. Early collagenization. Cellular fibrous tissue inside fascicle is gradually replaced by increasing amount of collagenous fibres. (Hæmalum and eosin.) (× 95.)

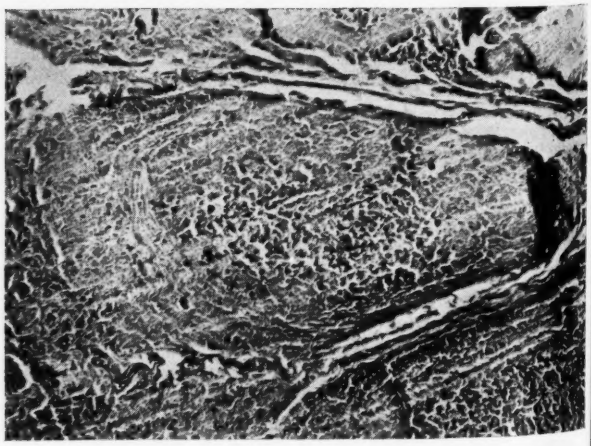


FIG. 53.—*Case* 1. Transverse section of graft. Late collagenization. Most of the fascicle is replaced by dense connective tissue. (Hæmalum and eosin.) (× 95.)

Graft.—Nerve-fibres cross the suture line into the graft and at the junction show considerable irregularity and criss-crossing (*Fig.* 46). The nerve-fibres extend into the graft for a distance of 25 mm. In the proximal sections they occupy twelve fair-sized bundles (*Fig.* 47) which decrease in number distally. There are myelinated fibres present to within a few millimetres of their termination. There is some endoneurial fibrosis of the fascicles but no marked thickening of the perineurium. The nerve-bundles are set in a mass of dense fibrous tissue. More peripherally the histological appearances vary in different parts of the graft, but in no definite order. Immediately distal to the innervated portion most fascicles show necrosis (*Figs.* 48, 49). In the centre of the bundle there is a mass of disintegrated tissue which may be entirely structureless or preserve the endoneurial framework, and this necrotic centre is enclosed by a cellular fibrous tissue (*Fig.* 50). The bundles may be clearly defined from the surrounding dense fibrous interfascicular tissue by a thickened perineurium or the

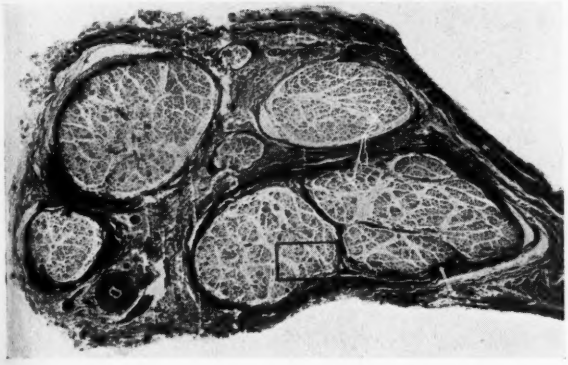


FIG. 54.—*Case* 2. Transverse section of central stump. Observe a number of large and some smaller bundles of normal appearance. There is only a moderate degree of interfascicular fibrosis. (Modified protargol method.) (× 13·5.)

perineurium may be indistinguishable from either extra- or intrafascicular fibrous tissue and in consequence the fascicles are imperfectly demarcated.

In the same section of the graft there are fascicles with central necrosis, fascicles completely filled by necrotic tissue, and fascicles occupied entirely by a fibrous tissue which may be cellular or in process of collagenization (*Figs.* 51–53). In the most distal part of the resected tissue (thought to be the peripheral stump) there is no evidence of nerve-bundles whatever and the sections consist of dense scar tissue. In view of the number of nerve-bundles present in the part of the peripheral stump resected at the time of the graft operation, it seems unlikely that this distal part is the peripheral stump.

Case 2.—A French soldier, A. M., aged 39 years, was wounded in the left upper arm on May 27, 1940. He sustained an extensive soft-tissue injury, with a complete lesion of the radial nerve. On Dec. 4, the nerve was explored. It was surrounded by dense fibrous tissue for a distance of 6·5 cm. and a neurolysis was performed.

On July 11, 1941, the patient was admitted to Winwick Emergency Hospital. As there was no evidence of recovery the nerve was re-explored on Oct. 2, 493 days after wounding. The damaged portion of the nerve was extensively scarred and 9·5 cm. were resected before obvious bundles were reached. The gap was bridged by a homograft taken from the radial nerve of a patient who had died four hours previously. The graft was held in position by three fine linen thread sutures, at the proximal junction, and four at the distal junction. The graft was of smaller diameter than the nerve-trunk and only about 70 per cent of the bundles in the proximal nerve-stump were in contact with the graft. The blood group of the recipient was 'A' and of the donor 'O'.

In early February, 1942, the patient applied for repatriation, but before leaving hospital he was anxious

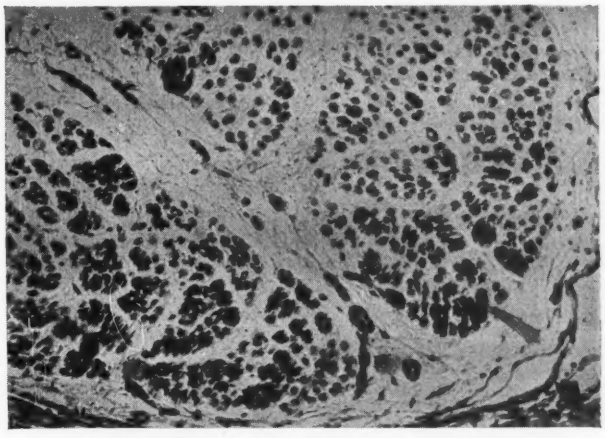


FIG. 55.—*Case* 2. High-power view of area in *Fig.* 54 enclosed in square. Normal proportion of myelinated (surrounded by a halo) and non-myelinated fibres. Slight degree of intrafascicular fibrosis, manifested in the increased thickness of endoneurial septa. (Modified protargol method.) (× 135.)

to have a more powerful grip. It was agreed that the graft should be re-explored under local anæsthesia, and that if the prospects of recovery were unfavourable a tendon transplantation should be performed at the same time. The operation was performed on Feb. 19, 140 days after the insertion of the graft. The graft was

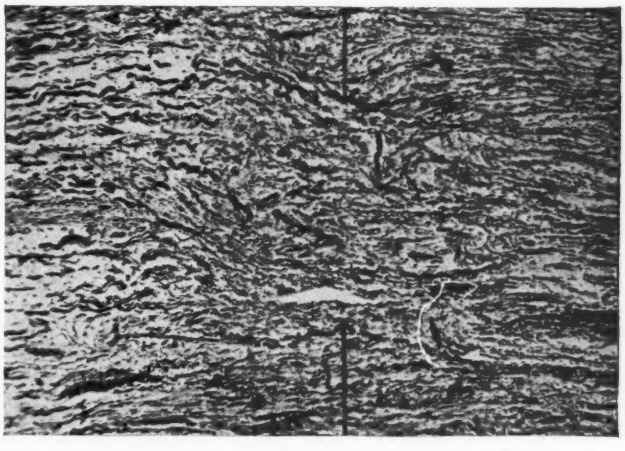


FIG. 56.—*Case* 2. Section through proximal suture line (marked by arrows). Central stump to the left, graft to the right. Considerable, but not excessive, irregularity and criss-crossing of nerve-fibres at junction. (Modified protargol method.) (× 42.)

identified without difficulty, it was firmer than at the time of insertion and adherent to surrounding tissues, but not to the same degree as in some of the older grafts. There was a neuroma 1 cm. in diameter at the proximal suture line. Electrical stimulation of the graft produced no sensory or motor response. Part of the graft and 2 cm. of the central stump were removed for histological examination.

HISTOLOGICAL EXAMINATION.—

Central Stump.—There are a number of large bundles, of normal appearance (*Fig.* 54), with myelinated and

non-myelinated nerve-fibres (*Fig.* 55). Towards the proximal suture line, however, there is some evidence of Schwann-cell proliferation.

Graft.—Nerve-fibres cross the suture line (*Fig.* 56) and penetrate the graft for a distance of 12 mm. Distal to this point the fascicular contents are largely necrotic (*Fig.* 57). Much of this necrotic tissue shows the ghost of the original connective-tissue framework consisting of a network of more deeply staining endoneurium enclosing nerve-tubes ballooned out by the swollen

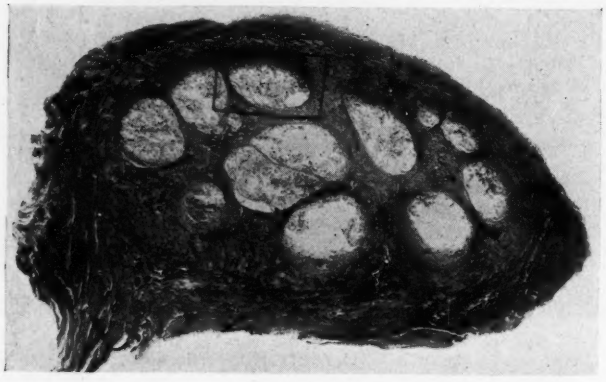


FIG. 57.—*Case* 2. Transverse section of graft distal to the point reached by the nerve-fibres. Fascicular contents are largely necrotic. All fascicles, with the exception of a centrally-placed one, show sickle-shaped cellular proliferation on their outer segments. (Hæmalum and eosin.) (× 15.)

myelin sheath (*Fig.* 58). In the more peripheral parts of the graft there are a number of necrotic fascicles forming a ring in the middle of the sections. The interfascicular tissue in the centre of this ring is necrotic, likewise the

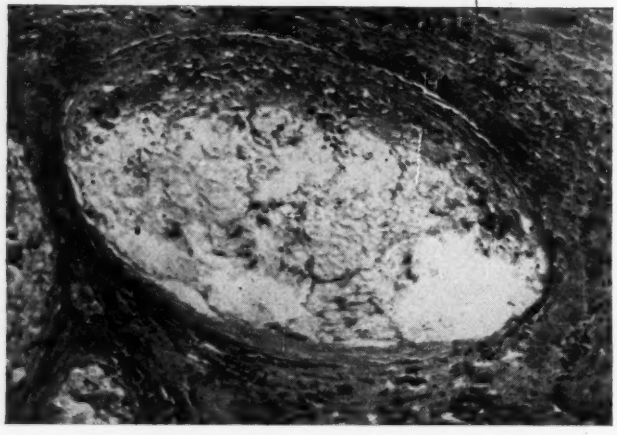


FIG. 58.—*Case* 2. High-power view of area in square in *Fig.* 57. Remnants of necrotic endoneurium and ghosts of ballooned-out myelin sheaths. Perineurium forming the inner half of circumference (bottom part of picture) is necrotic, that on the outer half (top part of picture) is healthy, with well-marked nuclear staining. Observe sickle-shaped cellular mass inside healthy perineurium (? survival of graft, or invasion by host connective tissue.) (Hæmalum and eosin.) (× 75.)

perineurium forming the inner half of the circumference of the fascicles. The perineurium forming the outer half of the circumference of the fascicles appears healthy and proliferated, with well-marked nuclear staining. Immediately adjacent to this healthy perineurium a sickle-shaped mass of cellular tissue occupies the outer segment of the fascicles. This cellular tissue is quite distinct from the interfascicular fibrous tissue and is clearly marked off from the circularly disposed perineurium. The abrupt transition from the interfascicular tissue to perineurium, and the definition of the perineurium from the sickle-shaped cellular mass occupying the outer part of the fascicles, is difficult to reconcile with the assumption of an invasion of the fascicles by the fibrous tissue of the host. The alternative conclusion is that there is survival and active proliferation of the original endoneurial connective-tissue elements of the graft fascicles, and one cannot exclude the possibility of some Schwann-cell proliferation in the sickle-shaped areas.

The terminal portion of the dissected mass of tissue consists of dense fibrous tissue in which there are no nerve-bundles and only a few aberrant nerve-fibres which have obviously grown in from neighbouring nerves.

Case 3.—A soldier, H. T., aged 24 years, was wounded in the right upper arm on May 29, 1940, and sustained a compound fracture of the lower end of the right humerus

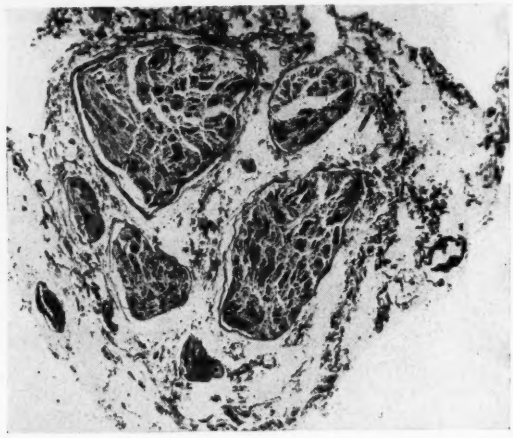


FIG. 59.—*Case* 3. Transverse section of central stump. There are several large bundles with a more or less normal proportion of myelinated and non-myelinated fibres. (Modified protargol method.) (× 15.)

and a complete lesion of the radial nerve. The wound became heavily infected, and it was not possible to explore the nerve until Jan. 20, 1941, 236 days after injury. After resection of the nerve-bulbs there was a gap of 6 cm. between the proximal and distal nerve-trunks. Because of the ankylosed elbow-joint it was impossible to close this gap, even after extensive mobilization of the proximal and distal nerve-trunks. The gap was therefore bridged by a homograft taken from the radial nerve of a patient who had died 60 hours previously. The condition of the graft was not entirely satisfactory as the bundles were difficult to identify and the tissues of the graft were abnormally soft. The blood group of both donor and recipient was 'A'. There was some post-operative wound infection and the sinuses were not completely healed for two months.

There was no sensory or motor recovery and on July 13, 1943, 904 days after insertion, the graft was re-explored, under general anæsthesia, and a tendon transplantation performed. The proximal end of the nerve was found without difficulty, but at a point corresponding to the proximal suture line it disappeared into a mass of scar tissue, and it was impossible to identify any of the graft with certainty. The proximal end of the nerve, together with a strand of tissue, which was possibly the remains of the graft, was removed for histological examination.

HISTOLOGICAL EXAMINATION.—

Central End.—There are several large bundles with myelinated and non-myelinated fibres (*Fig.* 59), some Schwann-cell proliferation, but no evidence of intrafascicular fibrosis.

Graft.—Nerve-fibres penetrate the graft for a distance of 15 mm. They are not, however, in well-defined fascicles, but run as small groups of aberrant fibres in the interfascicular tissue (*Fig.* 60). Even had they grown into the peripheral stump it is doubtful if this small number of fibres would have had any functional value. There is no trace of the original nerve-bundles of the graft. The resected tissue consists of dense fibrous tissue and some skeletal muscle; there is no evidence of the original graft elements (*Fig.* 61).

The following table gives the particulars of the remaining 5 cases. In each case the graft was taken from the corresponding nerve of a cadaver, as soon as possible after death. The number of hours that elapsed between the death of the donor and the insertion of the graft is given. In none of the patients was there any evidence of sensory or motor recovery. In the patient J. H. this could be attributed to severe post-operative sepsis. The convalescence of the remaining 4 patients was uneventful. All the grafts, with the exception of the patient, J. P., were re-explored under local anæsthesia. No sensory or motor response was obtained on electrical stimulation of the grafts in any of the patients.

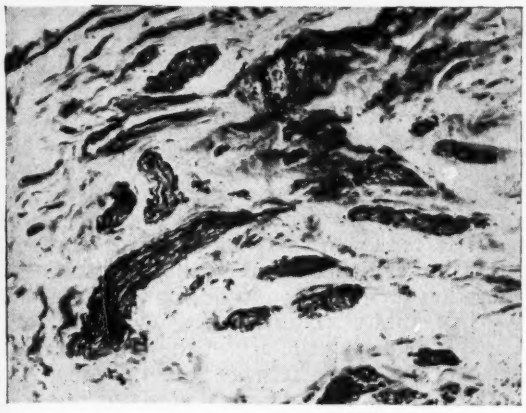


FIG. 60.—*Case* 3. Small groups of aberrant fibres in scar tissue of proximal end of graft. (Modified protargol method.) (× 66.)

DISCUSSION

The 8 cases of nerve homograft described here constitute a fair cross-section of the various types of injury to the large nerves of the limbs in which grafting may be indicated. They add to the already depressing list of homograft failures, testimony which ought to discourage the most sanguine from further clinical use at the present time. The use of the fresh homograft, the thermal and chemical treatment of stored homografts, modifications of operative technique such as plasma sutures, varieties of protective sleeve, and other expedients which have been tried from time to time—all these have proved of no avail. Loeb (1930) advanced a theory of 'organismal differentials' based on chemical characteristics to account for the fate of grafts, and more recently Gibson and Medawar (1943) and Medawar (1944) in their studies of skin-grafting have produced evidence that the reaction of the host to foreign tissue is the result of an "active acquired immunity".

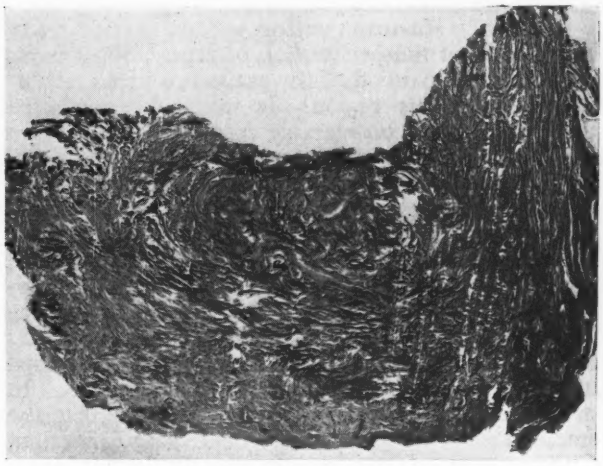


FIG. 61.—*Case* 3. Transverse section of the un-innervated part of graft. No trace of original fascicles. Section contains mostly dense, tendinous connective tissue. (Hæmalum and eosin.) (× 9.)

Table I.—DETAILS OF REMAINING 5 CASES OF NERVE HOMOGRAFTS

Patient	Age	Blood Group	Injured Nerve	Interval in Days between Wounding and Grafting Operation	Length of Graft	Hours after Death	Blood Group of Donor	Degree of Scarring of Graft Bed	Days betewen Insertion and Re-exploration	State of Graft	
										Identification	Adhesions
J. M.	55	AB	Radial	240	10 cm.	—	—	++	385	Easily identified	++
J. H.	26	O	Sciatic	462	25 cm.	8	A	+++	202	Graft could not be identified	—
J. P.	24	—	Posterior tibial	517	7 cm.	30	—	None	—	—	—
W. B.	21	O	Median	526	10 cm.	7	O	++	320	Easily identified. "Felt like a flexor tendon."	+
A. S.	28	O	Lateral popliteal	230	7 cm.	12	A	None	732	Graft very difficult to identify. "Apparently converted to scar tissue"	+++

Efforts to control this "active acquired immunity" can only be based on an understanding of the forces thus released against the donor tissue, which in turn demands a knowledge of the histopathological processes involved.

The main points of interest in the structure of the resected homografts are: (1) The partial re-innervation of the grafts; (2) The fascicular necrosis; and (3) The fibrous replacement.

Partial Re-innervation.—The most ready explanation of the penetration of regenerating axons into the proximal end of the grafts is a better vascularization of this region. It might be suggested that during the considerable interval of time from the initial injury to the graft operation, the progressive fibrosis of the isolated peripheral stump (Holmes and Young, 1942) will be accompanied by a decrease in its blood-supply and so the distal end of the graft is less efficiently vascularized. This argument, however, should apply with equal force to autografts, the majority of which are completely re-innervated (Seddon, Young, and Holmes, 1942; Barnes, Bacsich, and Wyburn, 1945), and animal homografts, where functional success occurs. In the case of the latter, it has been stated that the smaller size of the graft will facilitate vascularization. The important factor is, however, the size of graft relative to the size of the vascular pattern. Moreover, where there are adhesions, and this is especially so in the homograft, it is probable that many extra-neural vessels participate in the vascularization (Bacsich and Wyburn, 1945, a, b). In the three cases examined there was no evidence of any marked variation in the number of blood-vessels throughout the length of the graft. Spurling et al. (1945) also found it impossible to correlate the growth of axons into nerve homografts with the degree of vascularity. We agree with Seddon and Holmes (1944) that inadequate vascularization is not a satisfactory explanation of the partial re-innervation of homografts and accept their tentative suggestion that the length of graft traversed by axons is an index of the latent period during which the host acquires the active immunity.

How does the presence of host nerve-fibres affect the fate of the graft? There are two possibilities. Sanders and Young (1942) believe that in the re-innervated homografts of rabbits much of the graft tissue survives. For example, they state that the original architecture is preserved, that there is proliferation of graft Schwann cells, and the invading axons occupy the endoneurial tubes of the graft. There is no question of these animals (rabbits) possessing a tolerance to foreign tissue. Therefore it must be assumed that the new fibres in some way insulate and protect the graft against the hostilities of the host tissues and that in successful animal homografts the axons are able to traverse the entire length of the short grafts before active immunity is acquired and are thus able to protect it.

On the other hand, Bentley and Hill (1936) state that in the cat, where homografts, provided they are not too large, are successfully innervated, the graft tissue is totally destroyed. They contend that the new fibres provide their own sheaths from host Schwann cells and that the presence of host nerve-fibres does not affect the final fate of the nerve-graft, which, like the skin homograft, is ultimately completely replaced by host tissue. They therefore believe, and we are inclined to agree with them, that the function of the graft is to provide a necessary but temporary scaffolding for the new fibres. Success will depend on the nerve-fibres reaching the peripheral stump while the graft is still in a condition to act as a scaffold.

Fascicular Necrosis.—Whatever the nature of the forces mobilized against the graft in the first instance, the result is a necrosis of the fascicular contents and their subsequent replacement by fibrous tissue. There are scant records of the early changes in nerve homografts. Bentley and Hill (1936) described in the cat a heavy leucocytic infiltration of a nerve homograft at 60 days, while Sanders and Young (1942) noticed a considerable lymphocytic invasion of some of their rabbit nerve homografts after 25 days. Eden (1919), who transplanted a piece of human nerve into the subcutaneous tissues of another patient for 38 days, found, not Wallerian degeneration, but a slow necrosis of the nervous elements and their replacement partly by cells from the surviving graft and partly by proliferated host connective tissue. He, however, makes no comment on how the necrotic material is removed. In our series of homografts there was no evidence of macrophages or endothelial proliferation such as is found during repair of injured nerve in rabbits (Bacsich and Wyburn, 1945). Perhaps, considering the age of the graft, this is not surprising, but there remains the question of the method by which the necrotic material is removed.

It seems probable, although conjectural, that the nerve homograft, like the skin homograft (Medawar, 1944) at an early stage evokes something of the nature of an inflammatory reaction which later subsides. In the youngest homograft (140 days) the un-innervated fascicles are filled with necrotic tissue, except for a zone of sickle-shaped cellular fibrosis invariably found on the outer segments. In the oldest homograft (904 days) all that remains of the un-innervated portion is strands of scar tissue in the midst of muscle fibres. In the un-innervated portion of the homograft in *Case* 1 (355 days) there are fascicles completely filled with necrotic tissue, and others with an area of central necrosis enclosed by a zone of fibrosis. In this graft it is possible to see in the same section fascicles wholly occupied by fibrous tissue, which may be cellular or may be densely collagenized and with difficulty distinguished from the interfascicular tissue. The stage of fascicular necrosis appears to be gradually succeeded by a fascicular fibrosis until finally the original architecture is lost and the graft is represented merely by a homogeneous mass of dense connective tissue. We can find no reasonable explanation to account for the different conditions of the fascicles in *Case* 1. There is no relationship between the position of the graft fascicles in either longitudinal or transverse sections and their progress towards final obliteration.

Fibrous Replacement.—In the three grafts examined the rather loose connective tissue with a fair amount of fatty tissue which forms the inter-fascicular substance of a normal nerve is replaced by a dense fibrous tissue of the consistency of tendon.

It cannot be stated with certainty that there is no survival of the original graft tissue, but there is little doubt that the host fibroblasts invade and may possibly completely replace the original interfascicular tissue. That this may be so is supported by the observation that the older the graft the more difficult it becomes to distinguish it from surrounding tissues until finally the only clue to its identity is the knowledge of its former position, e.g. *Case* 3, where even on microscopical examination there is no evidence of the original graft (the initial unsatisfactory condition of the graft, and the subsequent sepsis would probably influence the final condition in this instance). In *Case* 2 the sickle-shaped fibrous areas involving the outer segments of the ring of necrotic fascicles might well represent an invasion of the surrounding host tissue towards the centre of the graft. As has already been noted, however, there is an abrupt transition from the dense interfascicular to the cellular intrafascicular fibrous tissue and the two areas remain separated by a well-preserved perineurium. In *Case* 1, there are a number of fascicles in part occupied by dense fibrous tissue directly continuous with the surrounding interfascicular tissue without any intervening perineurium, and others which have become totally collagenized and merged into the general fibrous tissue background. While, therefore, there is at one stage proliferation of the connective-tissue cells of the graft (sickle-shaped areas of cellular connective tissue), the microscopical picture of the late condition of the homograft is more suggestive of the total replacement of the necrotic fascicles by the tissues of the host.

The fate of a nerve homograft is fundamentally different from that of an autograft or an isolated peripheral stump (in many ways comparable to an un-innervated autograft), where the architectural characteristics are preserved and fibrosis is the result of the proliferation of their own connective-tissue elements. Moreover, in the case of the isolated peripheral stump, subsequent, although imperfect, innervation is possible (Holmes and Young, 1942 ; Barnes, Bacsich, and Wyburn, 1945).

Spurling et al. (1945) imply that the main deterrent to the further penetration of the nerve-fibres into the homograft is inter- and intrafascicular fibrosis. It seems, however, unlikely that there is further growth of axons after the host has acquired immunity, and if our interpretation of the subsequent sequence of events within the graft is correct, fascicular necrosis precedes the invasion and replacement by fibrous tissue which is a late condition and has not yet occurred in many of the un-innervated fascicles even after 355 days.

In the majority of cases there was severe scarring of the graft bed. Spurling et al. (1945) suggest that this may interfere with vascularization of the graft. It cannot, however, be a deciding factor, for in our two traction injuries of the external popliteal nerve there was virtually no scarring of the graft bed, and, furthermore, soft-tissue scarring did not prevent neurotization of the autografts reported by Seddon, Young, and Holmes (1942), and Barnes, Bacsich, and Wyburn (1945).

The blood group of donor and recipient were known in 5 cases, and in 2 of those the blood groups of donor and recipient were identical. The consensus of present opinion (Seddon and Holmes, 1944 ; Spurling et al., 1945 ; Medawar, 1944) regards blood compatibility of the recipient and donor as irrelevant to the problem of the homograft. The test of blood compatibility has been confined to the normal grouping. A more intimate serological analysis might produce a different result, but might equally well so limit the possible source of the homograft as to render the procedure in large measure impracticable.

Unless some method is devised of prolonging the presence of the homograft as a scaffolding for the regenerating nerve-fibres until the nerve gap is bridged, then there is no justification for the use of homografts for the repair of large gaps in peripheral nerves in man.

SUMMARY

Eight human nerve homografts are reported, all of them failures. With one exception the grafts were removed and examined histologically at times varying from 140 to 904 days after their insertion. In 3 cases the histological findings are given in detail.

We agree with Seddon and Holmes (1944) that inadequate vascularization is not a satisfactory explanation of the partial re-innervation of homografts, and accept their tentative suggestion that the length of graft traversed by axons is an index of the latent period during which the host acquires the active immunity to the homograft.

The fascicles of the un-innervated part of the graft undergo necrosis and are finally completely occupied by fibrous tissue, at first cellular, later collagenous.

The histological picture, after a period of 904 days, suggests that ultimately there is total replacement of graft by the tissues of the host.

The opinion is expressed that the function of the graft is to act as a temporary scaffolding for the regenerating nerve-fibres.

REFERENCES

BACSICH, P., and WYBURN, G. M. (1945, a), *J. Anat., Lond.*, **79**, 9.
— — — — (1945, b), *Ibid.*, **79**, 74.
— — — — (1945, c), *Proc. Roy. Soc. Edinb.*, Sect. B, **62**, 182
BALLANCE, C., and DUEL, A. B. (1932), *Arch. Otolaryngol.*, **15**, 1.
BARNES, R., BACSICH, P., and WYBURN, G. M. (1945), *Brit. J. Surg.*, **32**, 130
BENTLEY, F. H., and HILL, M. (1936), *Ibid.*, **24**, 368.
— — — — (1940), *Brit. med. J.*, **2**, 352.
EDEN, R. (1919), *Arch. klin. Chir.*, **112**, 471.
GIBSON, T., and MEDAWAR, P. B. (1943), *J. Anat., Lond.* **77**, 299.
HOLMES, W., and YOUNG, J. Z. (1942), *Ibid.*, **77**, 63.
LOEB, L. (1930), *Physiol. Rev.*, **10**, 547.
MEDAWAR, P. B. (1944), *J. Anat., Lond.*, **78**, 176.
SANDERS, F. K. (1942), *Brain*, **65**, 281.
— — and YOUNG, J. Z. (1942), *J. Anat., Lond.*, **76**, 143.
SEDDON, H. J., YOUNG, J. Z., and HOLMES, W. (1942), *Brit. J. Surg.*, **29**, 378.
— — — — (1944), *Surg. Gynec. Obstet.*, **79**, 342.
SPURLING, R. G., LYONS, W. R., WHITCOMB, B. B., and WOODHALL, B. (1945), *J. neurol. Surg.*, **2**, 79.

ANALYSIS OF A SERIES OF 454 INGUINAL HERNIÆ WITH SPECIAL REFERENCE TO MORBIDITY AND RECURRENCE AFTER THE WHOLE SKIN-GRAFT METHOD

By GEORGE B. MAIR

FIRST ASSISTANT TO DEPARTMENT OF SURGERY, UNIVERSITY OF DURHAM

A PRELIMINARY report on the use of whole skin-grafts for the repair of hernia has been published (Mair, 1945, a, b), but without reference to results. This paper deals with an analysis of a series of 454 inguinal herniæ operated upon by myself, of which 149 were repaired by the whole-skin method.

The purpose of this contribution is to discuss the results so far achieved by this method and to compare morbidity and recurrence against figures for other operations, both in this series and from other clinics.

No comparative statistics for the skin method of repair are available.

In assessing morbidity and recurrence figures, the conclusions reached are, with the exception of 43 cases, those of myself and a colleague. In the 43 exceptions the patients were soldiers. They were sent a questionnaire which was completed by the battalion Medical Officer.

For the purpose of this investigation an attempt was made to trace every patient for a minimum of one year after operation. In some cases the period is well over two years. It is of interest that of 21 recurrences, all save one developed within the first year, and most within nine months.

Number of Cases in the Series.—The total number of patients investigated was 402, but of these 52 had bilateral herniæ, making a total of 454 operations.

Proportion of Direct to Indirect.—Of the 454 herniæ, 104 were direct, that is, 22·9 per cent. Twelve of these were "saddle-bags", that is, there was an associated indirect sac on the same side.

Association with Strain.—No history of abnormal strain relating to the onset of the condition was given in 319 cases. In 5·2 per cent there was definite history of severe, and in 24·4 per cent there was a history of moderate strain, which, in the opinion of the patient, contributed to the onset of the condition.

Association with other Herniæ.—Twelve direct cases had an associated indirect sac upon the same side. In 52 cases there were bilateral herniæ. Four had a femoral hernia upon the contralateral side, 2 an epigastric hernia causing symptoms, and 1 a large umbilical hernia.

Death-rate.—One patient died on the eighth post-operative day. The cause of death was obscure, and not satisfactorily revealed by autopsy. Signs of internal hæmorrhage developed on the fifth post-operative day and the patient died three days later. At autopsy there was found an acute yellow atrophy of the liver and an intraperitoneal hæmorrhage, the source of which was not located, but was considered possibly to have sprung from an aneurysm of the splenic artery.

The operation was for a plastic repair of a large direct hernia using a whole skin-graft. No technical difficulties were encountered at operation, and the death proved an unexpected and unaccountable surprise.

Strangulation.—There were 10 cases of strangulation (2·2 per cent). In 4 of these the small intestine was involved, and in 6 only the omentum. Resection of gut was necessary in 3 of the 4 cases involving bowel. In the omentoceles the strangulated omentum was excised. There were no deaths. No attempt was made in any case to do more than deal with the strangulation and attempt to save life.

Incarceration.—Nine cases were incarcerated (1·9 per cent). At operation the constriction was freed and a suitable repair performed.

Reducibility.—The remainder of the series were reducible (95·9 per cent).

Associated Lesions.—Hydrocele was present in 3·5 per cent of cases, varicocele in 3 per cent, undescended testicle in 2·2 per cent, and chronic bronchitis in 8·8 per cent. Other conditions—for example, duodenal ulcer, cholecystitis—which have no direct bearing upon the aetiology, progress, treatment, or complications of inguinal herniæ are not included.

Special Types of Herniæ.—There was one true example of a hernia *en bis sac*, and seven of hernia *en glissade* where the cæcum alone was involved. They were all on the right side. In five of the direct cases the bladder was extrasaccular and related to the hernia, but caused no especial difficulty at operation.

There were 2 cases of cruroscrotal hernia. In these the spermatic cord traversed the femoral canal to enter the scrotum. The herniæ were both inguinal.

No examples of interstitial or properitoneal sacs were encountered.

Operations Performed.—All patients were treated by one of four operations: a classical Bassini; simple herniotomy with suture of the fascia transversalis and narrowing of the pillars of the internal abdominal muscular ring; a Gallie fascial hernioplasty;

Table I.—NUMBER OF OPERATIONS PERFORMED

	INDIRECT HERNIA	DIRECT HERNIA	TOTAL
Bassini	67	21	88
Herniotomy	90	4	94
Fascia	80	43	123
Skin-graft	113	36	149
Total cases	350	104	454

or by a whole skin-graft inlay. The technique of the whole skin-graft method has been described elsewhere (Mair, 1945, a, b).

In the following and other tables the first figure gives the percentage, whilst the second *pair* of figures indicates the number of complications out of the total number of cases considered, e.g., wound sepsis for the Bassini operation is 5·5 per cent, that is 5 cases of sepsis out of 88 operations (5/88).

EARLY POST-OPERATIVE COMPLICATIONS

Table II.—Early Post-operative Complications

Complications	Bassini	Herni-otomy	Fascia	Skin
Wound sepsis	5·5 (per cent)	3·1 (per cent)	4·8 (per cent)	3·3 (per cent)
	5/88	3/94	6/123	5/149
Hæmatoma wound	1·1 (per cent)	5·3 (per cent)	2·4 (per cent)	3·3 (per cent)
	1/88	5/94	3/123	5/149
Hæmatoma scrotum	3·3 (per cent)	1·0 (per cent)	2·4 (per cent)	3·3 (per cent)
	3/88	1/94	3/123	5/149
Orchitis	0	0	0	0·6 (per cent)
				1/149
Post-operative chest complications	10·2 (per cent)	22·3 (per cent)	13·0 (per cent)	12·0 (per cent)
	9/88	21/94	16/123	18/149

Comparison of these post-operative conditions (*Table II*) demonstrates that herniotomy in my experience carries with it the highest incidence of chest complications. The explanation for this is obscure, but those patients who most frequently developed chest complications were young and active soldiers, accustomed to a healthy outdoor life.

Wound Sepsis.—The highest incidence of wound sepsis was after the classical Bassini operation. I do not consider this to be other than a coincidence, and to be an observation of little practical value.

In regard to fascia and skin, the higher incidence of local wound sepsis follows the use of fascia; the difference is approximately 1·5 per cent, fascia having 4·8 per cent sepsis and skin 3·3 per cent. These cases generally cleared up rapidly. One of the skin cases persisted for four months, but upon re-examination one year after the wound had finally healed there was no sign of recurrence. It is only fair to add that the degree of sepsis was slight, and that after the third week only a faint stain was present on the 24-hour dressing.

Sepsis has given no trouble of consequence in the skin cases, but it has been found that the skin-graft operation may be associated with a curious phase during the early post-operative period.

During the end of the first week, and sometimes lasting well into the third, the wound may be slightly indurated and occasionally a little inflamed. In no case has this gone on to pus formation, nor has it been associated with pyrexia, pain, or constitutional upset. It is most probably due to local activity around the graft during the period of phagocytosis of the epidermis and infiltration of the graft with granulation tissue. The appearances suggest a very low-grade deep sepsis, and are not constant. It has been observed in approximately 25 per cent of my total series. By the end of three weeks from the date of operation the wound is entirely normal, the slight superficial redness has disappeared, and the induration generally gone. Occasionally there may be some very slight deep induration for a further week or ten days.

It is important to recognize this happening and also to note that in my experience it has been of no serious significance, there has been neither subjective local upset or constitutional disturbance. The end results were satisfactory.

It is important that at the original operation the skin preparation technique described elsewhere be adhered to (Mair, 1945, a, b).

Hæmatoma of Wound.—Every effusion of blood in relation to the wound has here been considered. There has been no example of a hæmatoma which required to be opened or which discharged more than a few drops of blood-stained fluid from a superficial bleb on the scar sometime during the early second week.

Herniotomy has been associated with the highest incidence of this complication. It is my opinion that this is largely due to straining by coughing during the early post-operative period, as it has been observed that these young men may be more restless coming out of the anæsthetic than sedentary workers, and older persons.

Hæmatoma of Scrotum.—As might be expected hæmatoma of the scrotum is not common after simple herniotomy, and only one case was encountered.

The skin-graft operation and the classical Bassini have the same incidence of this complication, 3·3 per cent. I incline to the belief that this is partly due to the sutures inserted immediately lateral to the pubis in these operations, and in the case of the skin repair, to one other factor. The external oblique is detached for about 1 in from its pubic attachment in order the better to expose the pubis and lower rectus sheath. This step is sometimes associated with oozing from vessels between that muscle and the rectus. This can migrate into the scrotum to cause hæmatoma. There was no case of a large hæmatoma and seldom was there more than some scrotal discoloration with slight swelling above the testis and in the line of the cord. The condition is more frequent when the testis has to be delivered into the wound.

Orchitis.—This complication was observed only once, and that in relation to a skin-graft repair. No explanation for it is forthcoming. The condition was not acute and subsided within a week of onset.

COMPARISON OF PERSONAL FIGURES WITH THOSE OF OTHER CLINICS

Sepsis.—O'Shea (1935) found an incidence of 3·8 per cent sepsis in uncomplicated cases taken as a whole and without regard to type of operation. In relation to fascia, Erdman (1923) had 4·8 per cent

sepsis, Lyle (1928) 1 per cent, and Fallis (1940) also 1 per cent. In some hands the figure is higher. My own figure for the fascial operation is 4·8 per cent.

The skin-graft repair has a 3·3 per cent incidence of sepsis after 149 operations. This compares quite favourably with the average figures for sepsis in relation to fascia, and is a little better than that quoted by O'Shea.

Post-operative Chest Complications.—Lucas (1937) gave carefully detailed figures for post-operative chest complications in relation to hernia operations and for different types of anæsthetic media. He classified his complications into severe, moderate, and slight. Discarding the slight cases and considering only the severe and moderate and after nitrous oxide, oxygen, and ether anæsthesia, he had, for 85 cases a total incidence of 30·6 per cent chest complications.

This is higher than in my own experience for any type of hernia operation, my highest figure being for herniotomy with 22·3 per cent chest trouble. Lucas is an anæsthetist. Other figures are available from surgeons.

Davis (1916) has analysed 1500 cases and found the incidence of 9·2 per cent post-operative bronchitis after the Bassini operation; on the other hand, Gibson and Felter (1930) had but 1·7 per cent. For the Bassini operation I found 10·2 per cent post-operative bronchitis in a series of 88 cases.

The figures published range from the low level of Gibson and Felter to the high levels of Lucas.

In regard to the skin operation I had 12 per cent as against 13 per cent with fascia.

Scrotal Hæmatoma.—Gibson and Felter (1930) found 3·1 per cent scrotal hæmatoma after the Bassini operation. This is almost the same as my own experience for the Bassini and skin operations, 3·3 per cent and 3·3 per cent respectively.

Erdman (1923) in relation to fascia had 9 per cent scrotal hæmatoma. This is higher than my own figures for fascia (2·4 per cent) and also for skin (3·3 per cent).

Davis (1916) found 7 per cent hæmatoma after the Bassini operation, a figure higher than those of Gibson and Felter (1930) or myself, whilst Fallis (1940) had but 0·8 per cent in his series.

Summary.—The figures of my series compare quite favourably with those considered from other sources, and the skin-graft operation is not associated with any high incidence of early post-operative complications of significance. In my hands the early post-operative complications for fascia and skin-grafts run closely together, and with no significant difference between.

It is necessary to compare the late results of the various operations which were followed up, and to endeavour to assess the evidence in relation to the efficiency or otherwise of the skin type of repair.

LATE RESULTS OF OPERATIONS FOR INGUINAL HERNIA

It was not possible to follow up all the cases, though a considerable effort was made to do so.

With few exceptions the results are determined by examination one year or over from the date of the original operation. In some cases an opportunity arose to see the patients within a year. *Table III* shows the interval after treatment before re-examination in relation to each of the four operations under consideration.

Table III.—Interval after Operation before Re-examination

Duration in Months	6–9	9–12	12–15	15–18	18–24	24–30	30–36
Bassini	0	0	4	11	9	4	0
Herniotomy	4	7	15	4	3	3	0
Fascia	0	0	30	15	30	10	1
Skin	3	9	66	9	0	0	0

Thus, of the 454 operations performed 237 were followed up, and of these, 212 were observed after one year.

Each patient was re-examined by two people. There were 43 cases in soldiers where it was not possible to re-examine them personally. These were sent a questionnaire which was filled in by their Army Medical Officer.

Table IV.—Late Post-operative Complications

Complications	Bassini	Herni-otomy	Fascia	Skin
Pain in the wound	14·2 (per cent)	0 (per cent)	5·8 (per cent)	1·1 (per cent)
	4/28		5/86	1/87
Hydrocele	0	0	0	1·1 (per cent)
				1/87
Varicocele	0	0	0	0
Atrophy of testis	0	2·7 (per cent)	0	0
		1/36		
Fatigue	11·5 (per cent)	0	2·3 (per cent)	0
	3/26		2/86	
Thickening of epididymis, or chronic orchitis	7·6 (per cent)	5·5 (per cent)	1·1 (per cent)	1·1 (per cent)
	2/26	2/36	1/86	1/87

In the cases of the Bassini and the group of herniotomies, the numbers traced are not large (*see Table III*), but suitable comparisons may legitimately be made between the fascia and skin repairs.

Pain in the Wound.—This is more common after fascia than with skin, 5·8 per cent as against 1·1 per cent.

I have been unable to trace observations based upon statistical evidence for this late complication in the literature, but feel that in the case of the series of skin-graft cases the numbers are not high enough to be an adverse criticism of the operation.

It is not easy to assess precisely any subjective symptom such as wound pain. One can be guided only by the patients' expressions of opinion. I have included each who complained of any wound

pain at all. Certain people have stated that they occasionally were aware of a 'funny feeling' in the operation area. This seems to be interpreted as meaning 'an awareness of the scar' and generally observed after exercise or when sweating. It has been included as 'pain'. It was not met with often.

Pain in the thigh wound is a complication peculiar to fascial operations. Again it is a subjective symptom. I found no instance where pain was complained of at the time of re-examination, but a number of patients stated that they had experienced pain in the thigh wound after leaving hospital. This persisted for only a few weeks in the average case, though for two months in one patient. Usually it was not severe, and in no instance did it compel him to refer to his doctor.

Hydrocele.—This complication has been indicated in the literature as occurring as often as in 13·4 per cent of cases after the Bassini operation (Bloodgood). Gibson and Felter observed it after 4 per cent of their Bassini cases (1930), and Patterson (1928) in 3·5 per cent after fascial repairs.

Only one case was found in my total series, and that followed a skin repair. The hydrocele was small and symptomless.

Varicocele.—No cases of varicocele were found.

In my view the absence of varicoceles and the presence of only one hydrocele is important in relation to the skin repair. It has been suggested by colleagues that the skin may be stitched so tightly around the internal ring as to compress the cord and give rise to one or other of these complications. Theoretically this is so, and yet, though the skin has in each case been disposed so as to protect effectively the internal ring, there have been no signs that the procedure is fraught with danger.

Atrophy of Testis.—This complication also might be expected if the cord were too tightly compressed. It was found only once, and that following upon a herniotomy. The operation was complicated by a scrotal hæmatoma which later was followed by atrophy. The hæmatoma was not so large as might have been expected in view of the sequel, but was approximately the size of a duck egg.

Fatigue.—This symptom may be complained of for long after any operation, and it is curious that it is more common in my series after Bassini repairs than by other methods. There is no reason why the Bassini operation should be more than usually prone to this complication.

Chronic Epididymo-orchitis.—This term is used here to embrace thickening of the cord in the upper scrotum, epididymitis, orchitis, and epididymo-orchitis.

Erdman found 15 per cent of Bassini cases showing late thickening of the cord in the upper part of the scrotum. It is not a condition which is commonly discussed in the literature, and I could find no other quoted figures for the lesion.

In my own series it was most common after the Bassini, and secondly, after herniotomy, 7·6 per cent and 5·5 per cent respectively. The fascial and skin repairs were equal with 1·1 per cent each.

Summary.—In the analysis of the followed up cases for late complications, the results for the skin repair compare satisfactorily with those for other operations, and with those of other surgeons. There is no evidence to suggest that the operation is associated with any danger of late difficulties referable to the implantation of the skin.

It is, in fact, surprising how completely free from deep thickening the operation area is. The scar is usually satisfactory.

I can report that the late results of these skin repairs have been satisfactory so far as morbidity is concerned.

The data peculiar to both types of inguinal hernia, and especially in regard to recurrence figures, must now be considered.

INDIRECT INGUINAL HERNIA

Sex Incidence.—There were 350 indirect herniæ, of which 4 per cent (14) were females.

Situation.—Of these, 212 (60·5 per cent) were on the right side, 138 on the left.

Type of Operation.—The cases were dealt with according to *Table V*.

Table V.—Types of Operation

Type of Operation	*No. of Cases*
Bassini	67
Herniotomy	90
Fascia	80
Skin	113

Approximately three-fourths of the cases required some form of repair.

Recurrence Rate.—Every case which presented a bulge over the operation area was considered to be a recurrence. If there were any doubts as to cure it was listed as failure.

The Bassini Operation.—Of the 67 Bassini operations performed for indirect inguinal hernia it was possible to trace only 22, and of these there were two recurrences (9 per cent). The numbers traced are not sufficiently large to be of value.

Of the two recurrences, one was examined thirteen months after operation and the other twenty-four. The first recurred after five months and the second after three.

Simple Herniotomy combined with Suture of the Fascia Transversalis.—This conservative operation was performed in 90 cases, and the late result traced in 32. There were 2 recurrences (6·2 per cent). Of these, one recurred at the end of the first post-operative month; the second patient was uncertain as to how long after operation before the swelling reappeared.

Fascial Repair by the Gallie Method.—This method was used in 80 cases and the results traced in 59. There were two recurrences, (3·3 per cent), one after eight months and the other after four.

Whole Skin-graft Repair.—The operation was performed 113 times and the results traced in 86. There was one recurrence (1·1 per cent). This followed six months after operation and two months after return to work. The skin repair was performed on a recurrent hernia originally repaired by fascia in a man aged 54. The hernia recurred ten months after the original operation and a skin repair was performed for the recurrence.

The graft was anchored with linen sutures. At the operation for recurrence each linen stitch was surrounded by a minute focus of infection in which

there was a pool of pus. From the pus no organisms were cultured. The graft had failed to attach itself at the medial end and the recurrence was in the form of a large direct hernia.

These results are considered in *Table VI*.

Table VI.—Recurrence Rates after Operations for Indirect Inguinal Hernia

Type of Operation	Number Performed	Number Traced	Percentage Recurrence
Classical Bassini	67	22	9·0
Herniotomy	90	32	6·2
Fascial repair	80	59	3·3
Whole skin-graft	113	86	1·1

DIRECT INGUINAL HERNIÆ

A total number of 104 operations were performed for direct inguinal hernia.

Sex Incidence.—98 were in males. All were in adults.

Situation.—54 were on the right side.

Type of Operation.—The cases were dealt with according to *Table VII*.

Table VII.—Direct Inguinal Hernia Type of Operation

Type of Operation	*No. of Cases*
Bassini	21
Herniotomy	4
Fascia	43
Whole Skin	36

In the cases which were dealt with by herniotomy the sac was funicular, and after its removal the rent in the fascia transversalis was sutured by a continuous stitch of chromicized catgut.

Type of Direct Hernia.—Of the total number of direct herniæ 32 were diffuse and 57 funicular. The remainder were either recurrent or associated with an indirect sac.

Results of Operation (*Table VIII*).—

The Bassini Operation.—Twenty-one patients were treated by this method and of these only 4 were traced. There were three recurrences (75 per cent). These developed ten, three, and eight months respectively after operation. I have seen no worse recurrence rate than this reported anywhere for direct hernia. One can only comment that the number is too small to be significant.

Simple Herniotomy.—This was performed for the funicular type of direct hernia in 4 cases, all of which were traced. Recurrence had followed in 3 (75 per cent). These recurred four, five, and four months after operation respectively.

Fascial Repair by the Gallie Method.—There were 43 operations of this type and of these 27 were followed up for re-examination. There were 8 recurrences. All were examined after an interval of at least one year, and they recurred after six, three, fourteen, six, three, and six months respectively. In 2 cases the patients were uncertain as to how long after operation before the swelling reappeared. The recurrence rate is 29 per cent.

Skin-graft Repair.—This technique was used in 36 cases and the late results traced in 27. There was no true recurrence, but one patient developed a femoral hernia on the same side as the skin operation. This patient had a long and complicated history of hernia. He was operated on originally for an indirect hernia and a Bassini repair performed. A recurrence developed and I did a fascial repair. This recurred, and the third operation was for a direct recurrent hernia. The skin technique was used. On examination ten months after operation, he was found to have a small but very typical femoral hernia. The posterior wall of the inguinal canal was perfectly firm and sound. I do not regard this as a recurrence. It should be mentioned that the patient has a direct inguinal hernia on the other side and is a chronic bronchitic. He is asthenic in type and a poor operative subject.

Table VIII.—Results of Operation for Direct Inguinal Hernia

Type of Operation	Number Performed	Number Traced	Percentage Recurrence
Classical Bassini	21	4	75
Herniotomy	4	4	75
Fascial graft	43	27	29
Skin-graft	36	27	0 One femoral hernia later developed

COMPARISON OF RESULTS WITH THOSE OF OTHER CLINICS

The following tables give results of operations reported by other clinics.

Table IX.—Recurrence Figures for Indirect Inguinal Herniæ treated by a Bassini Operation

Surgeon	Operation	Number	Percentage Recurrence
Fallis (1940)	Halsted	1386	8·6
Fallis (1940)	Bassini	214	13·4
Oedenarde (1922)	Bassini	French Navy	10·0
Goldner	Bassini	466	8·0
Coley (1924)	Classical Bassini	332	8·7
Andrews (1924) Massachusetts General Hospital	Bassini	—	9·0
Druner (1920)	Bassini	—	21·4
Andrews (1924), Bellevue, N.Y.	Bassini	—	7·5
Andrews (1924), Johns Hopkins Hospital, Boston	Bassini	—	10·9
Max Page (1943)	Bassini	London Police	20·2
Selinger (1927)	Classical Bassini	266	18·0
Erdman (1923)	Bassini	1093	6·67
Taylor (1920)	Bassini	816	5·6
Schwartz (1922)	Bassini	207	6·0
Average recurrence			11·8

Table X.—Recurrence Rate for Indirect Inguinal Herniæ repaired by Fascial Sutures

Surgeon or Clinic	Operation	Number	Percentage Recurrence	Follow-up
Grey (1940), Stobhill, Glasgow	McArthur	54	7·4	3 yr.
Foster (1936)	Gallie	101	7·0	1·5 yr.
Lyle (1928)	McArthur	100	3·0	1 yr.
Cattell-Anderson, McLoskey, and Lehman (1940)	McArthur	123	4·6	1 yr.
Andrews (1928)	McArthur	43	9·3	1 yr.
Gould (1940)	Gallie	87	9·2	1 yr.
Average recurrence rate for indirect herniæ			6·75	

Table XI.—Recurrence Statistics for Direct Inguinal Herniæ treated by the Bassini Operation

Clinic or Author	Number of Cases	Percentage Recurrence
Erdman (1923)	—	16·1
Andrews (1924), Massachussets General Hospital	—	15·0
Andrews (1924), Johns Hopkins Hospital	—	29·1
Taylor (1920)	77	22·0
Watson (1924)	—	20·0
Fallis (1940)	154	11·6
Coley (1924)	280	5·0
Max Page (1943)	London Police	25·8
Gibson and Felter (1930)	427	6·5
Average recurrence		16·8

Table XII.—Recurrence Rate for Direct Inguinal Herniæ repaired by Fascial Sutures

Surgeon	Operation	Number	Percentage Recurrence
Robins, McLoskey, and Lehman (1940)	McArthur	27	0
Lyle (1928)	McArthur	54	9·5
Cattell-Anderson, McLoskey, Lehman (1940)	McArthur	51	7·8
Cattell-Anderson, McLoskey,	Gallie	—	11·7
Average recurrence rate for direct herniæ			5·6

Indirect Inguinal Herniæ.—Analysis and comparison of the figures on *Tables VI*, *IX*, and *X* show that my figures for the Bassini operation and for fascia correspond closely with those of the average worker.

In the case of the skin-graft series (*TableVI*) the results are satisfactory. It can be claimed that there has not been a failure after primary operation, the only recurrence taking place after previous fascial hernioplasty.

Direct Inguinal Hernia.—The numbers of cases traced are small so far as any series of operations is concerned, but in the few cases of Bassinis and herniotomies they are so small as to be of little value. The results are bad. Even with fascia the results are poor and compare badly with those reported on *Tables XI* and *XII*, but there is dramatic improvement with the whole-skin technique, the results of which exceed any claims I have observed in the literature for this condition.

Selection of Cases.—There has been no selection of cases, and the series reported is consecutive, embracing all direct herniæ with which I have had to deal during the year, October, 1943, to October, 1944.

A total of 237 operative late results were traced, with 21 (8·8 per cent) recurrences (*Table XIII*).

Table XIII.—Analysis of Recurrent Cases

Type of Hernia	Interval before Recurrence	Type of Original Operation	Type of Recurrence	Age
	Months			
Left indirect	4	Fascia	Direct	40
Right indirect	4	Herniotomy	Direct	18
Saddle bag	5	Bassini	Direct	58
Saddle bag	6	Skin	Direct	53
Left Direct	8	Bassini	Direct	39
Right indirect	?	Herniotomy	Indirect	40
Left direct	6	Fascia	Direct	27
Right indirect	5	Herniotomy	Direct	19
Left indirect	3	Bassini	Indirect	30
Right indirect	4	Herniotomy	Direct	19
Left indirect	3	Fascia	Direct	25
Right indirect	14	Fascia	Direct	61
Left direct	6	Fascia	Direct	32
Right direct	?	Herniotomy	Indirect	23
Left direct	3	Bassini	Direct	54
Left indirect	8	Fascia	Indirect	64
Right indirect	3	Fascia	Direct	54
Right indirect	?	Fascia	Direct	41
Left indirect	6	Fascia	Direct	49
Right direct	?	Fascia	Direct	51
Right indirect	10	Bassini	Direct	44

Duration before Recurrence.—With one exception, all recurred under one year of operation, and of the 21 recurrences 13 did so before the seventh month. In 4 instances the patient was uncertain as to the time interval before the reappearance of the swelling. Thus, 13 out of 17 cases developed in the first post-operative six months.

Type of Recurrence.—Four cases only recurred as indirect herniæ, and in one of these the original operation was for a direct.

CONCLUSIONS

From an analysis of a series of cases of direct and indirect inguinal herniæ treated by myself, the evidence is overwhelming in suggesting that best results are achieved, in those cases which require more than simple herniotomy, by the use of the whole-thickness skin-graft technique.

The results of the skin-graft operation in the analysed series compare very favourably with any other results published for other types of operation from other clinics.

The early and late morbidity also compare favourably with the experiences of other clinics for other types of repair.

REFERENCES

Andrews (1924), *Ann. Surg.*, **80**, 225.
— (1928), *Ibid.*, **88**, 874.
Bloodgood, *Johns Hopk. Hosp. Rep.*

COLEY (1924), *Ann. Surg.*, **80**, 242.
DAVIS (1916), *J. Amer. med. Ass.*, **67**, 481.
DRUNER (1920), *Ibid.*, **74**, 925.
ERDMAN (1923), *Ann. Surg.*, **77**, 171.
FALLIS (1940), *Brit. med. J.*, **2**, 113.
FOSTER (1936), *Surg. Gynec. Obstet.*, **63**, 632.
GIBSON and FELTER (1930), *Ann. Surg.*, **92**, 744.
GOLDNER, *Hernia, Internat. Clin.*, **1**, 291.
GREY (1940), *Brit. med. J.*, **1**, 568.
GOULD (1940), *J. Roy. Naval Med. Ser.*, **26**, 122.
LYLE (1928), *Ann. Surg.*, **2**, 145.
LUCAS (1937), *Proc. Roy. Soc. Med.*, **4**, 145.
MAIR (1945, a), *Brit. J. Surg.*, **32**, 381.
— (1945, b) *Amer. J. Surg.*, **69**, 352.
MCLOSKEY and LEHMAN (1940), *Ann. Surg.*, **3**, 610.
O'SHEA (1935), *N.Y. St. J. Med.*, **35**, 473.
OUDENARDE and JEAN (1922), *Rev. Chir., Paris.*, **60**, 143.
PATTERSON (1928) *New Eng. J. Med.*, **198**, 191.
PAGE (1943), *Proc. Roy. Soc. Med.*, **36**, 185.
SELINGER (1927), *Ann. Surg.*, **86**, 82.
SCHWARTZ (1922), *Z. Chir.*, **49**, 1922.
TAYLOR (1920), *Arch. Surg.*, 382.
WATSON (1924), *Hernia*. St. Louis

A CASE OF ALBRIGHT'S SYNDROME
(OSTEITIS FIBROSA DISSEMINATA)

BY R. C. MURRAY, H. J. R. KIRKPATRICK, AND ELEMÉR FORRAI
RAIGMORE E.M.S. HOSPITAL, INVERNESS

FOR a number of years it has been recognized that generalized osteitis fibrosa (von Recklinghausen's disease) is caused by excessive secretion of parathyroid hormone, usually associated with adenoma of the parathyroid glands. Patients suffering from the malady exhibit widespread decalcification of the skeleton with foci of osteitis fibrosa, high values for serum-calcium and plasma-phosphatase, and low values for plasma inorganic phosphorus. Excessive amounts of calcium are excreted by the kidneys. Cases of fibrous dysplasia of bone occur, however, which, while resembling generalized osteitis fibrosa, differ from that disease in regard to the extent and distribution of the skeletal changes, in blood-chemistry, and usually in the absence of increased excretion of calcium by the kidneys. In several cases of this type explored for parathyroid adenoma, no tumour has been found. In 1937, Albright et al. described a group of such cases (4 females and 1 male) presenting certain clinical, radiological, and pathological features in common, which seemed to constitute a definite syndrome. The authors described the syndrome as characterized by :—

"*a*. Bone lesions which have a marked tendency to be unilateral and which show osteitis fibrosa on histologic examination.

"*b*. Brown, non-elevated, pigmented areas of skin which tend to be on the same side as the bone lesions.

"*c*. An endocrine dysfunction which in females is associated with precocious puberty."

In this group of cases the disease commenced in the early years of life. The generalized porosity of the bones of parathyroid adenoma was lacking, the bone lesions being spotty in distribution, with normal bones in between. Serum-calcium and plasma inorganic phosphorus values were within normal limits, and urinary calcium excretion was not elevated. Blood-phosphatase was elevated in cases with advanced bone lesions. In the female patients, the disease was attended by both precocious puberty and precocious bone-age, with early union of epiphyses. In the one male subject there was slight precocity of bone development, but no sexual precocity.

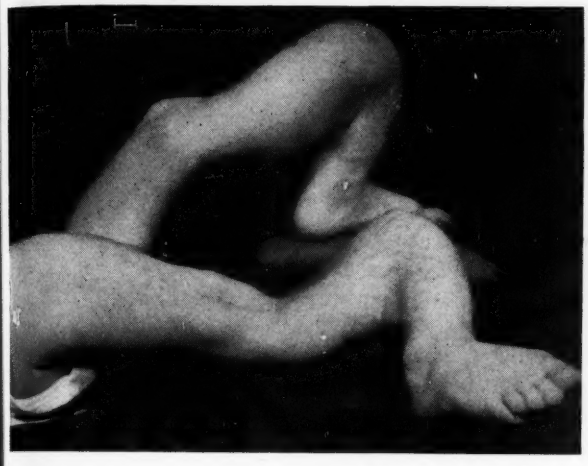
In the following year, Albright, Scoville, and Sulkowitch (1938) recorded 2 more cases of the syndrome occurring in male subjects. In one case, aged 21 years, with severe bone lesions, there was increased urinary excretion of calcium, although the values for blood-calcium and blood-phosphorus were within the normal range. The blood-phosphatase was elevated. In the other case, aged 14 years, there was definite precocity of bone-age, and the external genital organs were over-developed for the patient's age.

The scope of this disease is not clearly defined. Albright et al. (1937) review 13 cases of bone dysplasia of a similar kind recorded in the literature from 1922 onwards. Some of these cases exhibited the complete syndrome, while in others one or two of the triad of symptoms were absent, suggesting that the disease may occur in a less complete form than in the authors' own group of cases. Lichtenstein (1938) and Lichtenstein and Jaffe (1942) consider that the skeletal changes of the disease may occur in one, several, or many bones, and that fibrous osseous lesions with similar histology, localized to parts of single bones, may be regarded as representing a limited form of the disease. These authors emphasize the relative frequency of cases of mild or of moderate degree, which only rarely exhibit the extra-skeletal features of the syndrome. They review 90 cases of fibrous dysplasia of bone regarded by them as examples of the disease. In the majority the extra-skeletal signs were absent; and in their own experience of 23 cases, pigmentation of the skin was noted in only 2 cases, and only 2 of their female patients gave histories of precocious puberty. The reviews of Neller (1941) and Gorham et al. (1942) include small groups of cases regarded as incomplete forms of the disease.

Thus, while the histological characters of the bone lesions described for Albright's syndrome cannot be regarded as specific for any one disease entity, examples of the complete syndrome with one or more of its characters poorly developed, and cases which, while falling short of the complete syndrome, exhibit osseous lesions in combination with precocious puberty or skin pigmentation, seem to constitute a series which leads on to examples of

the disease in which involvement of one or more parts of the skeleton is its sole manifestation.

On the other hand, it seems probable that the disease may include, in individual cases, other features than the cardinal symptoms postulated by Albright et al. (1937). Albright and his colleagues (1938) observed over-development of the external genital organs in one male subject aged 14 years.



FIGS. 62, 63.—Photographs showing the condition of the lower limbs on admission.

Hyperthyroidism has been observed in some cases (Albright et al., 1938; Summerfeldt and Brown, 1939), and in one case recorded by McCune and Bruch (1937), and later by Sternberg and Joseph (1942), there was a history of thyrotoxicosis, and the autopsy findings included, in addition to hyperplasia of the thyroid gland, the thymus, and lymphoid tissue generally, basophilic adenoma of the pituitary, narrowing of the cortex and hypertrophy of the medulla of the adrenals, patent foramen ovale, and a Meckel's diverticulum. Multiple arteriovenous aneurysms involving the left upper extremity and probably the left lower extremity (Stauffer et al., 1941); co-arctation of the aorta and a rudimentary left kidney (Lichtenstein and Jaffe, 1942); and probable congenital cardiac defect (Dockerty et al., 1945) have been observed in single cases.

The literature on the syndrome in its complete form has been reviewed by Neller (1941), and Gorham et al. (1942); and Dockerty et al. (1945) describe 6 more cases. These reviews include 39 cases of the syndrome in its complete form recorded in the literature.

We describe below an example of Albright's syndrome in its complete form, as it occurs in the male subject.

CASE REPORT

HISTORY.—R.McK. was born in August, 1921, apparently a normal baby except for a large "birth-mark" on his body. His parents, four brothers, and five sisters suffered from no deformity. At the age of 4 he was noticed to be knock-kneed, but medical advice was not sought until he was 9 years old, by which time the deformity had become considerably worse. In November, 1930, the patient was seen by Mr. A. J. C. Hamilton and admitted to the Royal Northern Infirmary for examination and treatment. At that time the case notes record a severe degree of bilateral knock-knee, the left worse than the right. The upper end of each tibia was enlarged and nodular. Unfortunately the radiographs are no longer available. A wedge osteotomy was performed on the left tibia and fibula, and union apparently took place normally. The result was considered to be satisfactory, but it was thought probable at the time that an osteotomy of the left femur would be required later on. In July, 1931, the patient made this operation unnecessary by sustaining a fracture of the middle of the shaft of the left femur as the result of a relatively minor injury. The fracture united normally, but the deformities of his lower limbs grew steadily worse, until he ceased to be able to walk a year later. In spite of this, and although he fractured the right femur at the age of 15, twelve years elapsed before he next reported for examination at the Royal Northern Infirmary in January, 1943. By that time his deformities had become grotesque, and he was admitted to hospital for further investigation. Dr. J. F. Brailsford, to whom radiographs were sent for an opinion, diagnosed polyostotic fibrous dysplasia.

The patient was referred to the Orthopædic Unit, Raigmore E.M.S. Hospital, for investigation and treatment on March 20, 1944.

ON EXAMINATION.—At the time of his admission the patient was a rather pale young man, aged 22, of slender build and 115 lb. weight. When seen sitting up in bed no obvious abnormality was apparent, but on turning down the bedclothes the most fantastic deformities of the lower limb were disclosed. No verbal description can do these deformities justice, but the photographs (*Figs.* 62, 63) give a good impression of the legs below the knees. In addition there was gross bowing of the upper end of each femur, hyperextension deformities of both knees, and calcaneus deformities of both feet. The shaft of each tibia, in addition to its hairpin bend, was thickened. The range of movement in both knees and ankles was greater than normal; flexion of the hips was full, but abduction and rotation were restricted to a few degrees. The only other deformity which could be detected clinically was clubbing of the middle and ring fingers of the left hand.

There was, however, one other striking clinical feature, viz. a very large area of brown pigmented skin covering the greater part of the left side of his body from the level of the iliac crest below to the nipple line above (*see Figs.* 71, 72). In front this pigmentation did not extend beyond the midline, but posteriorly a band 2½ in. wide extended across the midline around the right loin to the plane of the anterior superior spine.

Cardiovascular system : The heart was enlarged and an apical systolic murmur was present. B.P. readings : 135/60–140/70. Electrocardiograph : Inversion of P.4. Slight tendency to right axis deviation.

There was no evidence of arteriovenous aneurysm or other vascular lesion.

Central nervous system : No abnormality detected.

Special senses : Visual fields normal.

Reproductive system : The testicles were of normal size, and there was no secondary sex abnormality.

X-ray Examination.—The whole of the skeleton was X-rayed and many unsuspected lesions revealed. The distribution of these lesions is indicated in *Fig.* 64, from

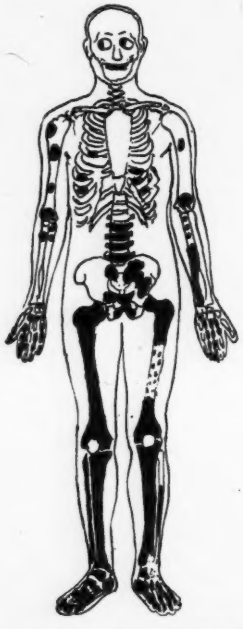


FIG. 64.—Diagram illustrating the distribution of osseous lesions. There was, in addition, a small area of the skull involved in the occipital region.

which it is clear that both sides of the body were equally affected, and that the lower half was far more seriously involved than the upper half.

In the most grossly affected bones, i.e. the tibiæ, the whole of the shaft was involved (*Fig.* 65) and showed the following features : deformity, expansion, thinning of cortex, decalcification, and a honeycomb of apparently cystic spaces of varying sizes.

In the femora, which were not quite so seriously affected, there were large areas showing similar changes but with areas of relatively normal bone lying between (*Fig.* 66). In this radiograph a healed fracture of the shaft is seen.

Most of the other long bones of the body contained one or several cyst-like areas (*Fig.* 67), the greater part of the shaft consisting of decalcified but otherwise normal bone. In some cases the cortex was expanded and very thin around these ' cysts.'

The pelvis, which was extensively affected, was distorted and compressed ; the lower four lumbar vertebræ were crushed vertically ; many of the bones of the hands (*Fig.* 68) and feet showed all the features described in the tibiæ, expansion being especially well demonstrated. In the skull only one area in the occipital region was affected.

The chest showed marked dilatation and some hypertrophy of the left ventricle, in addition to bone lesions in several of the ribs.

The kidneys showed no calculi, and uroselectan excretion was normal.

BIOCHEMICAL AND OTHER DATA (obtained during two periods of observation : (1) from January to May, 1943 ; and (2) during October, 1945).—

January to May, 1943.—

Serum-calcium : 9–10 mg./100 ml.

Plasma inorganic phosphorus : 1·08–1·58 mg./100 ml.

FIG. 65.—Radiograph of right tibia and fibula, showing deformity, expansion, and cystic appearance.

FIG. 66.—Radiograph of the left femur, showing greatest involvement in the upper half. A healed fracture is shown in the middle of the shaft, and the bone in this region appears to be more nearly normal.

Serum-phosphatase : 80 units (King-Armstrong) per 100 ml.

Blood-urea : 39 mg./100 ml.

Urinary calcium excretion : 0·12 g. (as CaO).

Urea-concentration test : normal range.

Glucose-tolerance test : blood-sugar curve normal ; a slightly low renal threshold for glucose.

Hæmatological investigation : normal results.

Wassermann and Kahn reactions : negative.

Bence-Jones proteose in the urine : on seven occasions during this period (March 11 to April 27) a trace of Bence-Jones proteose was present in the urine. A trace of albumin was also present.

October, 1945.—
Serum-calcium: 9·2–9·6 mg./100 ml.
Plasma inorganic phosphorus: 2·0 mg./100 ml.
Serum-phosphatase: 50 units (King-Armstrong) per 100 ml.
Blood-cholesterol: 170–180 mg./100 ml.

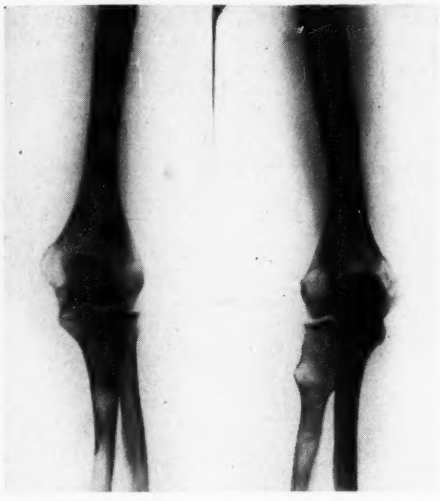
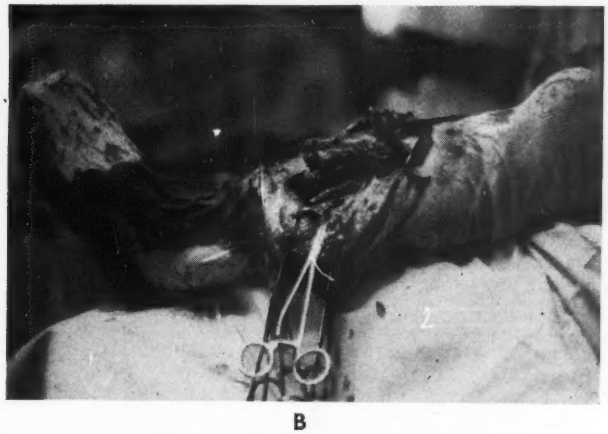


FIG. 67.—Radiograph of both elbows, showing cyst-like areas of involvement. Note the expansion of the neck of the right radius.

Serum-proteins: Total protein 7·0 g. per cent; albumin 5·2 g. per cent; globulin 1·8 g. per cent. (The above estimations were carried out on blood samples obtained while the patient was on a low-calcium diet of 0·1 g. intake per day.)

A



B

FIG. 69.—A, Appearance of left leg at operation after subperiosteal exposure of the tibia and fibula. The dense white fibula contrasts strongly with the darker, rounded tibia, which lies in front of it. B, Satisfactory alinement after osteotomy.

Two calcium balance experiments were carried out during this period:—

a. For a period of four days on a daily intake of 0·1 g. calcium.
There was a negative balance of 0·49 g. calcium.
Urinary excretion, 0·64 g. calcium.
Fæcal excretion, 0·25 g. calcium.

b. For a period of three days on a daily intake of 0·5 g. calcium.
There was a positive balance of 0·49 g. calcium.
Urinary excretion, 0·24 g. calcium.
Fæcal excretion, 0·77 g. calcium.
Basal metabolic rate: + 10 per cent.

Treatment.—The general considerations on which the treatment of this patient were based are discussed later.

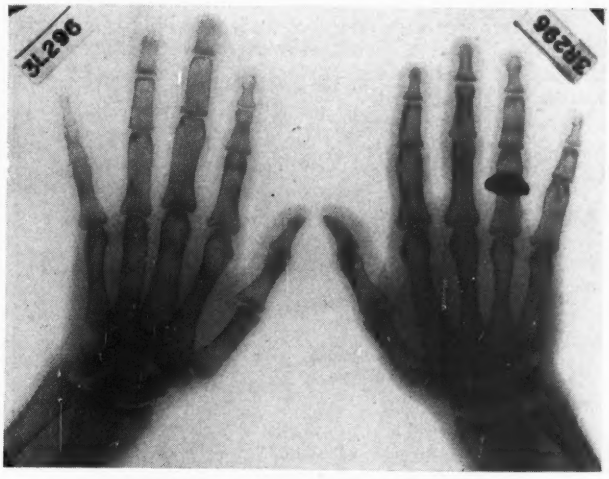


FIG. 68.—Radiograph of both hands, showing diffuse involvement of metacarpals and phalanges with expansion.

OPERATIVE TREATMENT.—

First Operation (*April* 1, 1944).—*Osteotomy of Right Tibia and Fibula.* Subperiosteal exposure of the middle two-fourths of the right tibia and fibula. The fibula was found lying behind the tibia and, at its maximum convexity, actually medial to the tibia. Using an electric saw, about 3 in. of the fibula was excised, and rather more of the tibia. The soft tissues were freed subperiosteally for 2 or 3 in. on the concave side of the bone ends, which then fitted together in reasonable alinement.

During the operation it was noted that the consistency of the bone varied very considerably. In some places it cut like normal bone, but in most places it was very easy to cut, especially where there were cyst-like spaces filled with what appeared to be fibrous tissue. Overlying these 'cysts' the cortical bone was very thin, but elsewhere the whole thickness of the shaft was of a homogeneous consistency without obvious distinction between cortex

and cancellous bone, and indeed without a medullary cavity. In these homogeneous areas the density of the bone was less than normal, solid but porous, and cutting quite easily.

Three to 4 in. of length were lost by this operation, and it was found necessary to excise a large piece of skin before closing the wound. The limb was then immobilized in plaster.

Rather surprisingly, no complications followed this operation; the circulation in the foot was not impaired, the patient had little pain, and the wound healed by first intention.

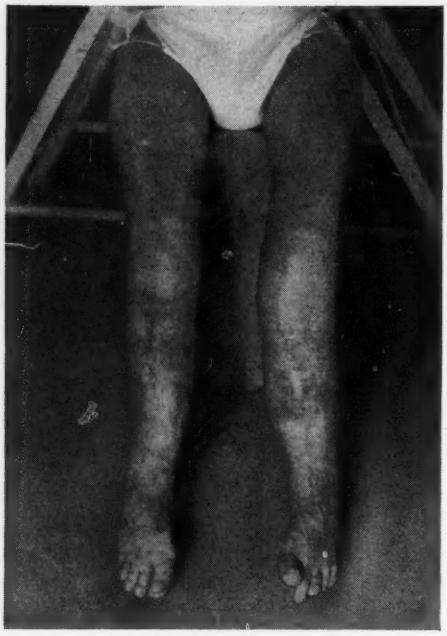


FIG. 70.—Appearance of the lower limbs after union of osteotomies.

Second Operation (*April* 18).—*Osteotomy of Left Tibia and Fibula.* This operation was carried out in a similar manner to the previous operation. The tibia was found to be even more affected than in the right leg, and for 3 in. of its length consisted only of a thin cortical shell filled with a soft yellowish-brown material. The fibula, on the other hand, appeared to be of normal texture, and its smooth white hard surface contrasted strongly with the rough, pinkish, and yielding surface of the tibia (*Fig.* 69, A, B). About 4 in. of both bones was excised with good correction and after this the fibula acted as a strong bony buttress behind the tibia.

This operation was followed by pyrexia, which subsided after aspiration of a hæmatoma. No other complication was experienced, and the wound healed satisfactorily.

Third Operation (*May* 26).—*Osteotomy of Right Femur.*—The bowed upper end of the femur was divided in two places 3 in. apart, and small wedges of bone were removed. The adductors were divided and the limb was immobilized in a Thomas splint with adhesive strapping extension tied to the end of the splint, which was fixed in wide abduction.

Fourth Operation (*June* 10).—*Osteotomy of Left Femur.* This was carried out as in the previous operation. In this leg the periosteum and bone were extremely vascular and bleeding was difficult to control. A Thomas splint again was used, both legs now being in extreme abduction.

POST-OPERATIVE TREATMENT.—By immobilizing in Thomas splints with strapping extension it was possible to obtain further correction of the femoral and tibial deformities by moulding, pads, and slings. When it was considered that maximal correction had been obtained, plaster-of-Paris was applied over the top of the adhesive strapping extensions, and the use of the Thomas splints continued.

On Aug. 14 the limbs were examined out of plaster and all the osteotomy sites were found to be sufficiently firm clinically to allow exercises (*Fig.* 70). Splintage between exercises, however, was continued for several months.

On Jan. 19, 1945, the patient was fitted with corset-topped callipers, hinged at the knees, and began to walk.

FIGS. 71, 72.—Photographs showing the patient after correction of the deformities, standing in his callipers. Note areas of pigmentation.

He made such good progress that he was allowed home after a few weeks, but two months later was re-admitted complaining of pain in the left thigh, and radiographs showed an incomplete fracture of the lower end of this shaft. It was evident that the callipers were not taking sufficient weight, and tuber-bearing rings were therefore added. Since then his progress has been satisfactory, and he is now able to get about quite well with the aid of sticks. The photographs show him standing in his apparatus (*Figs.* 71, 72).

Recently aluminium therapy as advocated by Helfet (1940) has been carried out, but insufficient time has elapsed to enable us to assess results.

Pathological Examination of Bone and Pigmented Skin.—

1. BONE (removed from the right tibia and fibula on April 1, 1944; and from the right femur on May 26.—*Macroscopical Examination.*—The consistency and structure of normal bone was lacking. The tissue was soft and cut easily. In some parts it consisted of soft fibrous tissue, which felt 'gritty' to the touch, covered by a thin shell of cortical bone. In other parts much of the thickness of the specimens consisted of soft bone of a uniform, finely porous structure. Portions of the finer parts of the tibia and femur incinerated to demonstrate the architecture of the bone revealed striking changes from the structure of normal bone. There was no apparent differentiation into cortical and cancellous zones. The tissue from the tibia exhibited a fine, almost uniform

honeycomb structure; the tissue from the femur, areas of compact porous bone and areas of coarse and fine honeycomb structure. The tissue from the femur which was weighed before and after incineration was composed of 62 per cent organic matter and 38 per cent mineral matter, as compared with 33 per cent organic matter and 67 per cent mineral matter of normal bone.

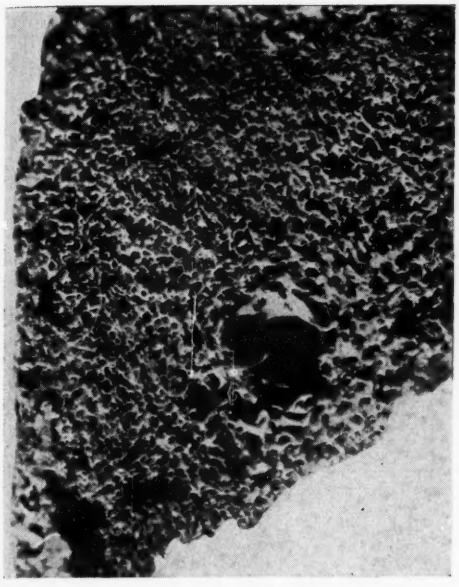


FIG. 73.—Bone from the right tibia, incinerated to demonstrate the architecture. Shows fine, almost uniform honeycomb structure without differentiation into compact and cancellous zones. (× 7·5.)

FIG. 74.—Bone from a normal tibia at approximately the same level as the abnormal bone, incinerated to demonstrate the architecture. (× 7·5.)

FIG. 75.—Bone from the right femur incinerated to demonstrate the architecture. Shows compact porous bone with areas of coarse and fine honeycomb structure. (× 7·5.)

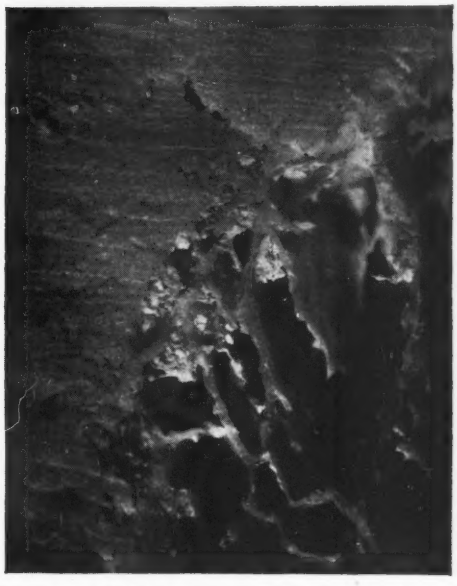


FIG. 76.—Bone from a normal femur at approximately the same level as the abnormal bone, incinerated to demonstrate the architecture. (× 7·5.)

In *Figs.* 73 and 74, incinerated bone from the tibia is compared with incinerated bone taken from approximately the same level of a normal tibia.

In *Figs.* 75 and 76 incinerated bone from the femur is compared with incinerated bone taken from approximately the same level of a normal femur.

Histological Examination.—The normal structure of bone was replaced by numerous irregularly-formed, imperfectly-calcified trabeculæ of osteoid tissue in a matrix of cellular connective tissue. The cortical zone was extremely narrow. Bone formation and resorption were in active progress.

a. Cortical tissue: In the more active areas the cortex formed an interrupted zone. There was well-marked osteoblast and osteoclast activity and Haversian canals were widened. In the less active areas the cortical zone

was continuous, and in some parts there was a mosaic pattern due to irregularly disposed Haversian systems. The outer surface of the cortex was covered by a fairly wide zone of fibrous tissue.

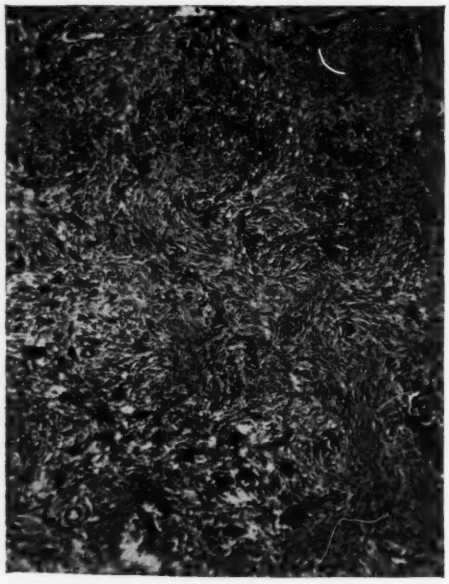


FIG. 77.—Section of active cellular area of osteitis fibrosa showing foci of commencing osteoid tissue formation and foci of giant cells. (× 52·5.)

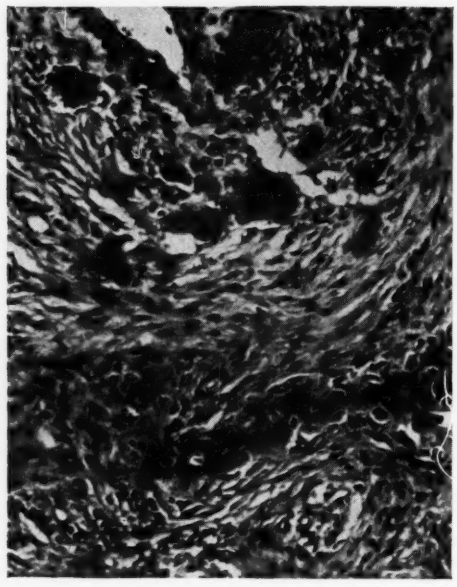


FIG. 78.—Higher magnification of a field depicted in *Fig.* 77. (× 150.)

FIG. 79.—Section of area of osteitis fibrosa showing narrow irregular trabeculæ of osteoid tissue. Matrix formed of more mature fibroblasts. (× 52·5.)

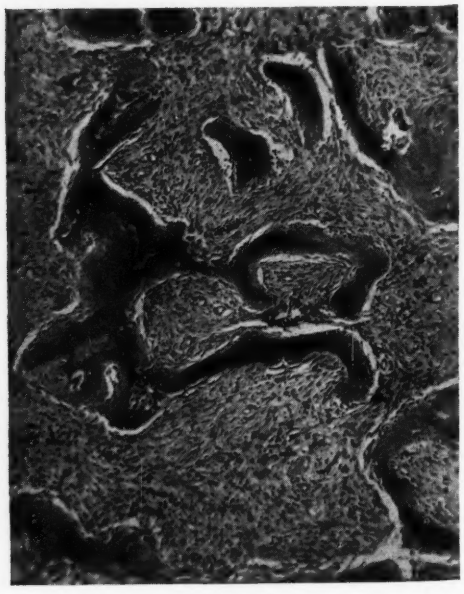


FIG. 80.—Section of relatively quiescent area of osteitis fibrosa showing some calcification of central parts of trabeculæ of osteoid tissue. Matrix more mature and fibrous. (× 52·5.)

b. Deeper tissue : The structure varied with the consistency of the tissue examined, but in all parts bone formation and resorption were in progress. The softer parts were composed of a very active tissue consisting of a matrix of closely packed, plump, spindle-shaped cells with deeply staining nuclei, many small foci of osteoid tissue in process of formation, and groups of giant-cell, multinucleated osteoclasts often related to spaces from which osteoid tissue had been absorbed (*Figs.* 77, 78). In adjacent areas young osteoid tissue appeared as numerous irregular trabeculæ ringed with osteoblasts, with little or no deposition of calcium salts ; osteoclasts were scanty and the matrix was composed of smaller, more mature fibroblasts (*Fig.* 79). In firmer material, the tissue was relatively quiescent in appearance. The trabeculæ were irregular but larger, with some deposition of calcium salts in their central parts ; the matrix was more mature and fibrous (*Fig.* 80). The tissue as a whole showed many thin-walled blood-vessels, and recent small hæmorrhages were present in

the more cellular parts. No ' foam-cells ' were present, and no cartilage.

2. BIOPSY OF PIGMENTED SKIN.—The stratum Malpighii was thinner than normal, and there was a moderate degree of melanin pigmentation in its deeper part. Superficially there was a little keratosis. In the corium, arrector pili muscles were prominent, and there was a little perivascular round-cell infiltration. No nævus cells were present.

DISCUSSION

In the case described above, the diagnosis of Albright's syndrome is based on the combination of progressive fibrous dysplasia of bone beginning early in life, the radiological and histological appearances of the osseous lesions, the absence of changes in the blood chemistry characteristic of parathyroid adenoma, and the presence of pigmentation of the skin. Pigmentation of the skin is more extensive on the left than on the right half of the body, and the history of the patient suggests that the earlier involvement of the skeleton was more marked on the left side. Unusual features exhibited by this case are: (*a*) the low values for plasma inorganic phosphorus; (*b*) the presence of a trace of Bence-Jones proteose in the urine; and (*c*) in some parts of the cortical bone examined, a mosaic pattern due to the irregular disposition of Haversian systems. On two occasions in 1943 the values for plasma inorganic phosphorus were 1·08 and 1·58 mg./100 ml., respectively, and in October, 1945, the values were 2·0 mg./100 ml. on two occasions. In the cases recorded in the literature, values for plasma inorganic phosphorus have usually fallen within the normal range, but low values have been observed occasionally (Albright et al., 1937, 1938). As far as we can ascertain, the presence of Bence-Jones proteose in the urine has not been previously observed in this disease. Hummel (1934) recorded a mosaic pattern in bone from a male subject aged 11 years, but apparently this has not been observed in other cases. Calcium metabolism experiments were essentially normal, both on a low calcium intake of 0·1 mg. calcium per day (Bauer et al., 1929), and on a basal intake of 0·5 mg. calcium per day.

Radiological observation does not reveal extension of the disease to other parts of the skeleton during the past three years, and there are no notable changes to be observed in the existing lesions. However, the high plasma-phosphatase values during the same period point to a considerable degree of activity of the existing lesions, and this is borne out by the histological appearances of activity observed in tissue removed from the tibia and femur at operation.

Treatment.—The ideal treatment of this case would consist of: (1) treatment of the general condition with the object of restoring the bone to normal; and (2) correction of the deformities. With the exception of Helfet's (1940) aluminium therapy (discussed below), no hope of benefit from non-surgical treatment could be found in the literature. X-ray therapy had been tried in previous cases both on bone lesions and pituitary gland, but without any apparent effect. (Albright et al., 1937.)

The patient's main concern was to be able to walk again. This could be achieved either by correcting the deformities or by amputating below the knees and fitting artificial legs. Non-union after osteotomy was not especially feared, for already osteotomy had been successfully carried out at the age of 9 years, and accidental fractures had united. The main doubt associated with osteotomy was whether it would be possible to correct the deformities of the tibiæ without damage to the main vessels and nerves of the legs. There was also considerable doubt as to whether the bones of the lower limbs would be strong enough, after correction or amputation, to support the weight of the body. The problem was discussed with a surgical appliance maker, who expressed the view that he could make some form of calliper if the deformities of the thighs and legs were corrected sufficiently to bring the knees and feet into roughly the same vertical plane as the hips. It was decided, therefore, to attempt correction of one leg, and, if this failed, to carry out below-knee amputations, followed by osteotomies of the femora.

FIG. 81.—Radiograph of the upper end of the femur, showing sclerosis around ' cyst ' through which osteotomy had been carried out sixteen months previously.

It is evident from the above operation reports that no serious complications followed osteotomy. Adequate correction was achieved by excision of a large amount of bone (3–4 in. of the tibiæ) at the site of maximal deformity, and this, together with the wide subperiosteal stripping of soft tissues, ensured that the vessels and nerves were not unduly stretched. It appears, then, that correction of even the grossest deformities in long bones can be undertaken with safety if the surgeon is prepared to sacrifice sufficient length of bone.

It is further evident from this case, in which six osteotomies were performed through severely affected bones, that union does take place within normal time limits. This is true even when the osteotomy is through a ' cystic ' area, as in the left tibia and the lower of the two left femoral osteotomy sites. Radiographs of the latter (*Fig.* 81) sixteen months after operation show a ring of sclerotic bone around

the 'cyst', the contents of which probably remain soft and fibrous, unchanged and unossified. Judging by radiographs taken over a period of three years, there is no evidence that the soft contents of these 'cysts' are ever replaced by bone; they remain as constant points of weakness, liable to fracture, as demonstrated in this case by a fracture occurring as the result of weight-bearing through an old fracture site apparently united for twelve years.

It is suggested, therefore, that when an osteotomy is carried out through a cystic area it is advisable to excise the contents and fill with bone. The chief technical difficulty is likely to be in finding a suitable donor site, but in cases such as this where large wedges of bone are removed in order to correct deformity, sufficient bone from this source would probably be available to fill the cavity. It is now regretted that this procedure was not adopted in this case.

The fear regarding the capacity of the diseased bones to bear weight was justified when a fracture of the left femur occurred as the result of walking. The callipers worn at that time were corset-topped and consequently not sufficiently weight-bearing. Tuber-bearing rings, therefore, were added and during the past six months the patient has been walking, first with the aid of crutches and latterly sticks, and there has been no other sign of bone stress.

In planning further treatment, the hypothesis put forward by Helfet (1940) on the causation of generalized fibrocystic disease of bone, unassociated with parathyroid adenoma, and the treatment he has based on this hypothesis, are of great interest. According to this hypothesis, the secretory activity of the parathyroid glands is stimulated by the phosphate of the blood, and the bone lesions are the result of chronic hyperparathyroidism caused by chronic hyperphosphatæmia. The treatment consists of the administration of aluminium acetate or gluconate to precipitate a part of the phosphate of the bowel to prevent its absorption. In a small group of cases Helfet records good results with this treatment. The general condition of the patients improved and there was increase in the density of the bones. In one case for which calcium balance studies are recorded, there was a negative balance before and a positive balance after the commencement of treatment. Dockerty et al. (1945) report some improvement with this treatment in one of their cases of Albright's syndrome.

In the case described above, the mechanism by which treatment which reduces the absorption of phosphate from the bowel might effect improvement is not apparent. The values for plasma inorganic phosphorus have tended to be low, and the values for calcium have been normal. However, in the biochemical data on his cases furnished by Helfet (1940), there are no abnormally high values for blood inorganic phosphorus, and in one case which derived considerable benefit from treatment with aluminium acetate, at one stage before treatment was begun the inorganic phosphorus was lower than normal.

Aetiology.—Various theories have been advanced to explain the aetiology of Albright's syndrome. Albright and his colleagues (1937, 1938) regard the localization of the osseous lesions and their tendency to unilateral distribution as precluding an endocrine or metabolic basis as the primary cause of the disease, and suggest that the symptoms may be an expression of an embryological defect or of a disseminated neurological disturbance, the gonadal anomaly resulting from afferent nerve impulses to the anterior pituitary. Lichtenstein and Jaffe (1942) believe that the malady has its basis in a defect of development, the skeletal changes resulting from perverted activity of the specific bone-forming mesenchyme. Sternberg and Joseph (1942) reject the idea that developmental defect alone can explain the dynamic sequence of events observed in the osseous lesions. They believe that the syndrome is the result of a complex endocrine disturbance, and that the progressive character of the bone lesions can only be explained on the basis of a disturbance in metabolism. These authors invoke the idea of a local tissue susceptibility to explain the tendency of the bone lesions to be unilateral in distribution, and cite instances of endocrine syndromes in which tissue changes have been predominantly unilateral. In Helfet's (1940) hypothesis, also, the underlying cause of the osseous changes in generalized fibrocystic disease is a general metabolic anomaly.

Apart from the gonadal dysfunction in female patients, evidence of endocrine disturbance has been lacking in the majority of the recorded cases of the disease, and we agree with those authors who believe that the syndrome can be best explained on the theory of a congenital anomaly as the basis of the disease. The recorded pathological studies and our own observations, however, lend little support to the view that the skeletal changes result from a primary perversion of activity of the specific bone-forming mesenchyme, and seem rather to indicate that they are secondary to some extra-skeletal disorder of calcium-phosphorus metabolism, a part of a congenital anomaly, with an incidental localizing mechanism, partly congenital and partly acquired. In parathyroid adenoma, in addition to the generalized decalcification of the skeleton, there are the multiple foci of excess of tissue change, the foci of osteitis fibrosa, which are presumably related to incidental factors of localization; and such incidental factors may be of a similar kind to those which determine the localization of the bone lesions in Albright's syndrome. It is difficult, however, to explain the tendency of the lesions in Albright's syndrome to be unilateral in distribution in the early stages of the disease and in the milder cases, and of the pigmentation to involve the skin of the side of the body predominantly affected with the bone changes, except on the assumption of some congenital peculiarity of organization of the tissues of bone and skin. In a wide field of pathology, variability in the functional quality of the walls of blood-vessels exercises a potent influence on the localization of disease, and apparently also on pigmentation of the skin (Burrows, 1932), and it may well be that localization of the foci of osteitis fibrosa in both parathyroid adenoma and Albright's syndrome is determined by a mechanism of this kind: in parathyroid adenoma a qualitative change in the walls of vessels acquired as a result of fortuitous events such as trauma and fresh stresses and strains resulting from initial lesions; in Albright's syndrome

similar changes which are partly congenital and partly acquired as the disease progresses.

We wish to thank Mr. A. J. C. Hamilton and Dr. Leys for permission to refer to clinical data concerning this patient while he was under their care in the Royal Northern Infirmary; Dr. Gotlieb and the staffs of the Radiological Department of the Royal Northern Infirmary, and Raigmore Hospital; Mr. T. C. Dodds, Edinburgh, for preparing the microphotographs; and the Medical Superintendent of Raigmore E.M.S. Hospital, for permission to record the case.

REFERENCES

ALBRIGHT, F., BUTLER, A. M., HAMPTON, A. O., and SMITH, P. (1937), *New Engl. J. Med.*, **216**, 727.
— — SCOVILLE, B., and SULKOWITCH, H. W. (1938), *Endocrinology*, **22**, 411.
BAUER, W., ALBRIGHT, F., and AUB, J. C. (1929), *J. Clin. Invest.*, **7**, 75.
BURROWS, H. (1932), *Some Factors in the Localisation of Disease in the Body*. London: Baillière, Tindall & Cox.
DOCKERTY, M. B., GHORMLEY, R. K., KENNEDY, R. L. J., and PUGH, D. G. (1945), *Arch. intern. Med.*, **75**, 357.
GORHAM, L. W., CAMPBELL, E. H., HOWARD, W. P., DONHAUSEN, J. L., and RUST, N. H. (1942), *Clinics*, **1**, 358.
HELFET, A. J. (1940), *Brit. J. Surg.*, **27**, 651.
HUMMEL, R. (1934), *Roentgenpraxis*, **6**, 513.
LICHTENSTEIN, L. (1938), *Arch. Surg.*, **36**, 874.
— — and JAFFE, H. L. (1942), *Arch. Pathol.*, **33**, 777.
MCCUNE, D. J., and BRUCH, H. (1937), *Amer. J. Dis. Child.* **54**, 806.
NELLER, J. L. (1941), *Ibid.*, **61**, 590.
STAUFFER, H. M., ARBUCKLE, R. H., and AEGERTER, E. E. (1941), *J. Bone Jt Surg.*, **23**, 323.
STERNBERG, W. H., and JOSEPH, V. (1942), *Amer. J. Dis. Child.*, **63**, 748.
SUMMERFELDT, P., and BROWN, A. (1939), *Ibid.*, **57**, 90.

SACCULAR DIVERTICULOSIS OF THE JEJUNUM DUE TO RETICULUM-CELL SARCOMA

BY A. GLANDON WILLIAMS
ASSISTANT HON. SURGEON, ROYAL SALOP INFIRMARY, SHREWSBURY
AND JOHN H. FODDEN
PATHOLOGY DEPARTMENT, ROYAL HOSPITAL, SHEFFIELD

DIVERTICULOSIS of the jejunum can be classified as primary and secondary. The former is purely a mucosal herniation through the musculature of the bowel wall. The diverticula are multiple and always spring from the concave or 'vascular' border of the bowel, and communicate with the bowel by a constricted neck at which the bowel musculature stops short. The case to be described is a rare type of diverticulosis occurring mainly in the third and fourth parts of the duodenum and the whole of the jejunum, being the result of multiple sarcomatous tumours in the wall of the gut.

CASE REPORT

HISTORY.—The patient, Mrs. J. L., aged 70, was admitted to the Royal Salop Infirmary on June 6, 1945, with severe and continuous epigastric pain, persistent vomiting, and loss of weight.

She described herself as quite well until 1938, except for occasional attacks of diarrhœa and constipation, from which attacks she had suffered for a few years at infrequent intervals. In 1938 she developed severe epigastric pain, which was associated with persistent diarrhœa, but no vomiting. Her treatment at this time consisted of a daily enema for about three weeks, and gradually her symptoms disappeared. In 1943 she had a recurrence of symptoms. During the interval she was doing her full work and feeling quite well. In 1943 she was bombed out, her husband died, and her only son was sent overseas. Epigastric pain, passing through into the back, was the first feature. It was present every day and all day, and made worse by meals. Her appetite was poor and all food had a bad taste. There was no vomiting or eructation. She was admitted to Grimsby Hospital for five weeks. Diarrhœa was present at this time, and the diagnosis of carcinoma of colon was suspected. A barium enema and barium meal examinations were carried out, and according to reports communicated there was no abnormality. During her stay at Grimsby Hospital her diarrhœa considerably improved on a fat-free diet and she was discharged.

In January, 1945, she again became ill with epigastric pain, which was associated with vomiting. This symptom was at first intermittent, but later became persistent, occurring one hour after meals; relief from pain followed the vomiting. There was no history of hæmatemesis. She stopped taking solid food towards the end of March and began taking Benger's, etc. Vomiting became less frequent and she lived principally on Benger's, milk, glucose, and olive oil, and also a few nutrient enemata. Diarrhœa was absent during this prolonged illness.

She was first seen by one of us (A. G. W.) on June 5, 1945, and the diagnosis of subacute small-intestinal obstruction was made. Arrangements were made for her admission next morning to hospital.

ON ADMISSION.—She was pale and dehydrated, and had obviously lost a good deal of weight. There was diffuse tenderness in the epigastrium. No mass could be felt, and there was no enlargement of the liver or spleen. Ascites was absent, and rectal examination revealed no abnormality. X-ray examination following a barium meal revealed the condition of multiple diverticulosis of the duodenum and jejunum (*Fig.* 82). Soon after admission she received two pints of blood, following which she had a small reaction associated with a temperature and a rigor.

AT OPERATION.—On June 8 an upper abdominal laparotomy was performed under nitrous oxide, oxygen, and ether. A quick examination revealed two areas of constriction in the upper jejunum.

The liver, gall-bladder, and stomach appeared normal. One of the large diverticula seen on X-ray examination was confirmed at operation. Attention was then paid to the jejunum with a view to resection. At a distance of 12 in. from the duodenojejunal flexure the first stricture was located. The left border of the greater

omentum was adherent to the bowel. This was easily separated and an abnormal area of jejunum was found. The antimesenteric border for a distance of ¾ in. was "greyish-white" in colour and sacculated, and the wall was felt to have lost its muscle tone. The whole circumference of the bowel in this area was affected in the same manner. The distal end of this portion of the bowel was almost completely stenosed, and in its mesentery there was a small gland about ½ in. in diameter, and about 1½ in. from the serous coat. Proceeding about 12 in. down the jejunum, a second pathological lesion was discovered. This consisted of a loop of bowel, two limbs of which were adherent to each other, and both were adherent to the mesocolon,

FIG. 82.—Radiograph following a barium meal showing only the radiological appearances of multiple large and small diverticula of the duodenum and jejunum.

descending colon, and the lateral border of the great omentum. This latter was easily separated from the jejunum, which, in its turn was easily freed from the mesocolon.

On further manipulation, the adherent loops of bowel were as easily separated, and a condition very similar to that described above was found in the proximal limb of this jejunal loop. In this instance, there was an added dimpling over the antimesenteric border, suggesting that at some date there had been a minute perforation. Present in the mesentery opposite this region was a large soft lymph-gland, approximately 2 in. in diameter, and at a distance of 2 in. from the bowel wall. It was decided that a resection of jejunum was necessary for double stricture of the bowel associated with diverticulosis, and appearances suggestive of malignant disease. A wide resection of 3 ft. of jejunum from a point 5 in. from the duodenojejunal flexure, including the mesentery and the affected lymph-glands, was performed, and an end-to-end anastomosis completed. This portion of gut included that part of jejunum adherent to the second affected limb.

PROGRESS.—The patient made a remarkable, practically symptomless recovery. There was no vomiting or any other complication.

In four weeks she had obviously put on a fair amount of weight, and she was discharged to a convalescent home on July 10 in quite good condition. Here she remained for approximately four weeks, and came up to see me at my Out-patients' Department on Aug. 20 looking extremely fit, and feeling so well that she had made the fifteen-mile journey alone. She said that she had not felt so well for many, many years, and her bowels were behaving excellently. On examination, she had no tenderness in the abdomen, but in the region of the anastomosis there was a suggestion of a swelling. There were no other swellings in the abdomen, and the liver and spleen were not palpable. There was no evidence of ascites, and the patient's physical condition was remarkably improved. A blood-count was done that day and showed a moderate degree of secondary anæmia with a normal white-cell count and differential. Arrangements were made for a barium meal and 'follow-through' examination to be carried out two days later. About one week later, inquiries were made regarding the result of the X-ray examination, and it was learned that the patient had not put in an appearance for that investigation.

Further inquiries disclosed that she was not well. On Sept. 8 her doctor asked me to see her again. His opinion was that she had suffered a metastasis in the thoracic spine. Her state of health was very poor, and she had been suffering from severe root pains in the left side of her chest. Large doses of veganin had been taken for the past ten days, but these were now losing their effect. Examination of the thoracic spine revealed some tenderness in the region of the 4th thoracic vertebra, and some slight lateral curvature in this region. Palpation of the abdomen revealed the same indefinite swelling that had been felt at her previous examination, but now the abdomen seemed more distended. She was extremely constipated, probably because of her veganin, and she was admitted to a Nursing Home in Shrewsbury, and an X-ray examination of the spine and chest revealed a deformity in the region of the 4th thoracic vertebra, confirming the diagnosis of neoplasm. The lungs appeared healthy. With enemata and aperients, an action of the bowels was obtained, following which she became incontinent of fæces and urine. She took very little fluid, was drowsy, and her condition deteriorated rapidly, culminating in death on Sept. 12.

There had been neither vomiting nor signs of intestinal obstruction, and the exact cause of death was impossible to determine. A post-mortem examination was, unfortunately, not permitted.

THE SPECIMEN.—This was 3 ft. of small intestine, being comprised mainly of the jejunum. Scattered along the surface of an otherwise apparently normal bowel were many tuberose swellings. Two large ones approximately 2 cm. in diameter were situated proximally and they became progressively smaller towards the distal end of the jejunum. They were for the most part separate, but were sometimes confluent. They nowhere involved the whole circumference of the gut wall, and were not localized to any particular region of the wall. Thus, in this important respect they differed from the congenital type of diverticulosis. They were dull grey, and contrasted well with the rather congested bluish-grey colour of the normal gut. Where their junction with the normal gut occurred, it was common to see patches of deep purple congestion of an inflammatory reaction, covered by a thin fibrinous sheet.

The nodules were firm to touch, and there was an apparent increase in rigidity and slight stenosis of the bowel wall where the nodules abruptly joined normal bowel. This latter feature was markedly accentuated at two places approximately 12 in. apart where a saccular

dilatation progressed into an almost complete stenosis of the bowel lumen. On opening the lumen of the gut these swellings were seen to be actual pouches, the wall of which was composed of thick white, firm, homogeneous

FIG. 83.—Photomicrograph showing the replacement of the circular and longitudinal muscle layers by the compact cellular sarcomatous growth. A few isolated strands of muscle can be seen within the tumour area. (× 40.)

FIG. 85.—Showing the moderate reticulin formation within the tumour. (× 90.)

tissue in which no muscle coat could be identified. The normal pale brown mucosal rugæ of the gut ended abruptly at the mouths of these pouches and gave way to a lining of pale yellowish-green slough. The floor of the pouches was coated with this soft granular debris. There were two enlarged encapsulated mesenteric lymph-nodes: one, by far the larger, measured 5 cm. in diameter. This, on section, was a mere shell of solid tissue whose centre was a mass of creamy necrotic debris.

Histological Description of the Diverticula.—The histological picture of all the separate diverticula suggested an infective granuloma, but was that of a reticulum-cell tumour confused partly by an inflammatory reaction consequent upon the mucosal necrosis and partly upon the cellular reaction to the proliferation of tumour cells.

In sections of the pouches the residual tumour formed a band of fairly even width, 0·3 cm. approximately, situated sometimes in the line of, and replacing, the muscle coat; and where the whole wall had been eroded, forming a dome projecting from the serous surface. There was a marked proliferation of primitive reticulum cells tending to be formed in symplasma, with a fair amount of mitotic activity, and these sheets of cells were spreading through the muscle layers and destroying them. The cells had oval poorly-staining nuclei, usually no nucleolus, and cytoplasm was scanty. They were

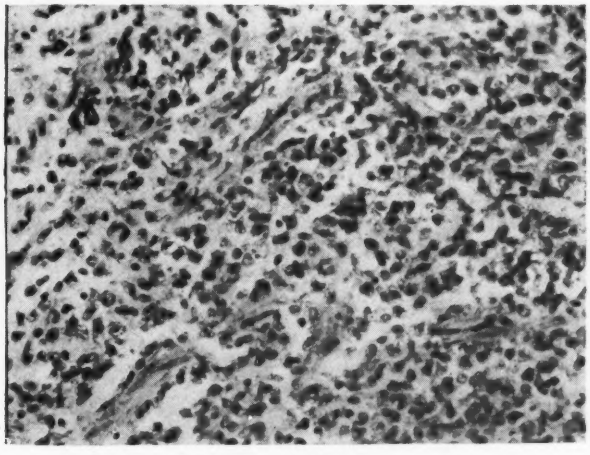


FIG. 84.—High-power photograph showing the type of cell present in the growth. (× 200.)

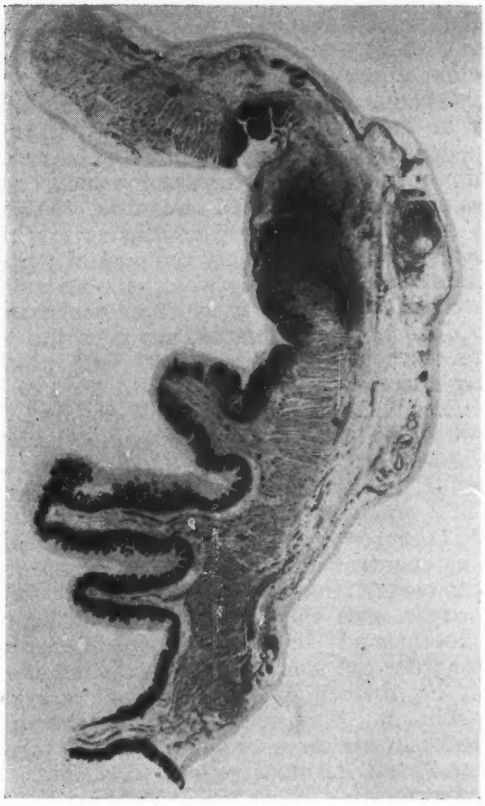


FIG. 86.—A low-power view of a section through the floor of one of the small pouches. (× 3½.)

nowhere phagocytic, and formed a moderate amount of reticulin which was laid down in lines parallel to the blood-vessels. There were numerous eosinophils scattered amongst the reticulum cells, but no plasma cells or Sternberg-Reed giant cells. There was no collagen formation except at the periphery, where there was a zone of œdema, fibrosis, and lymphoid infiltration outside the tumour. (*Figs.* 83–86.)

The large lymph-node showed none of the normal architecture of a gland. The main mass was composed of necrotic tissue containing abundant fragments of nuclear material. This was bounded by a narrow zone of reticulum cells, and outside this was a zone of fibrosis, dilated lymph-vessels, histiocytes, plasma cells, eosinophils, and lymphoid aggregates, gradually changing to fatty connective tissue.

CONCLUSION

The degree of lack of differentiation of the cell-type, and the marked infiltration, coupled with stromal destruction, classified this tumour as a reticulum-cell sarcoma. The histological features described are common to both the dictyo-syncytial type and the polymorphic reticulum-celled type of growth (Robb-Smith, 1938).

SURVEY OF LITERATURE

In the literature consulted, the terms 'lymphosarcoma' and 'lymphoblastoma' have been used freely to describe malignant conditions affecting lymph-nodes and lymph-follicles in the bowel. Only rarely has the histologically distinct reticulum-cell type of tumour been identified from the more usual malignant type of tumour composed of lymphocytes. However, the term 'lymphosarcoma' is used here in the 'Survey of Literature' only, to facilitate comparison with other recorded cases, but a pathological distinction exists and should be recognized.

'Lymphosarcoma' of the small intestine usually occurs in the ileum (Fraser, 1945). Sarcoma of the duodenum and jejunum appears to be rare.

Simpson-Smith (1939) reported 3 such cases in a series of 70 small-intestinal sarcomata. Morison's review (1941) of 2434 autopsies and 10,705 biopsy specimens yielded 21 primary tumours of the small intestine. Of these, 4 only were lymphosarcomata, and he described one case in which a lymphosarcoma of the duodenojejunal junction involved the whole circumference of the bowel and had produced saccular dilatation of the lumen. In the 126 cases of intestinal 'lymphosarcomata' collected by Ullman and Abeshouse (1932), the anatomical localization of the tumour was duodenum 4, duodenum plus jejunum 1, duodenum plus stomach 1. The rest were ileal and colonic. In 59 cases collected by Libman (1900) he found the duodenum and jejunum to be as common a site as the rest of the ileum. Cheever (1932), from an analysis of his own 16 cases, states that the frequency of incidence of 'lymphosarcoma' seems to increase with its distance from the stomach, and he found it to be rare in the duodenum and most common in the terminal ileum. Weinstein (1932) gives the order of occurrence in his cases as ileum, cæcum, jejunum, transverse and sigmoid colon, duodenum, and descending colon. From an analysis of the published cases with regard to the age incidence of lymphosarcoma of the small intestine, this tumour seems to be rare in old age, and occurs commonly during the 1st, 3rd, and 4th decades.

DISCUSSION

Primary malignant lymph-node tumours form an uncommon cause of intestinal obstruction, and increase in the diameter of the intestinal lumen seems just as prone to occur as constriction. In the case described by Morison in which the tumour had produced a saccular dilatation of the lumen, the growth was solitary and X-ray examination had revealed nothing. Out of the series of Ullman and Abeshouse 18 lymph-node sarcomata showed dilatation which was in some cases described as aneurysmal, but in no case did the dilatations simulate multiple well-demarcated diverticula or give an X-ray picture remotely resembling one which appeared indistinguishable from the condition of multiple diverticulosis.

It may, in fairness, be inferred from the operative finding of a large aneurysmal bulging of the duodenal wall along its *antimesenteric* border, and from the X-ray picture, that the pouches seen in the duodenum were of the same nature as those described in the resected jejunum. The interest attached to the present case centres around the large number of pouches and the length of gut involved, the site of the sarcomata, and the X-ray findings before operation.

It is suggested that from the beginning the tumour was multicentric and had its origin in the reticulum cells of the lymph-follicles within the submucous layer of the duodenum and jejunum. These probably formed rounded globular tumours which underwent central necrosis; subsequent mucosal sloughing completed the picture of ulceration. These are pathological pouches or 'tumour diverticula' the creation of which can be imagined from the histological description. The tumour destroys stroma, does not form collagen save in very small amounts, and has the effect of weakening and destroying the muscle wall; it may so cause dilatation. Further, paralysis of the remaining muscle may be brought about by the destruction of its nerve plexus, and thus a localized organically weakened wall, coupled with obstruction, would be subject to a raised intraduodenal pressure.

SUMMARY

A condition of 'secondary' diverticulosis of the duodenum and jejunum has been described. The aetiology of the diverticula was multiple reticulum-cell sarcomata originating in the submucous lymph-follicles.

REFERENCES

CAMERON, A. L. (1938), *Brit. J. Surg.*, **108**, 203.
CHEEVER, D. (1932), *Ann. Surg.*, **96**, 911.
FRANK, L. W., MILLER, A. J., and BELL, L. C. (1942), *Ibid.*, **115**, 544.
FRASER, KENNETH (1945), *Brit. J. Surg.*, **128**, 479.
LEWIS, D. L. (1939), *Ann. Surg.*, **26**, 541.
LIBMAN, E. (1900), *Amer. J. med. Sci.*, **120**, 309.
MORISON, J. E. (1941), *Brit. J. Surg.*, **113**, 139.
ODGERS, P. N. B. (1930), *Ibid.*, **68**, 592.
ROBB-SMITH, A. H. T. (1938), *J. Path. Bact.*, **47**, 457.
SIMPSON-SMITH, A. (1939), *Brit. J. Surg.*, **26**, 429.
ULLMANN, A., and ABESHOUSE, B. S. (1932), *Ann. Surg.*, **95**, 878.
WALKER, R. MILNES (1945), *Brit. J. Surg.*, **128**, 457.
WEINSTEIN, M. L. (1932), *Amer. J. Surg.*, **17**, 355

A FURTHER REVIEW OF THE INTERINNOMINO-ABDOMINAL OPERATION, BASED ON 21 PERSONAL CASES

By GORDON GORDON-TAYLOR, K.B.E., C.B., Surgeon Rear-Admiral
and DAVID H. PATEY
FROM THE SURGICAL DEPARTMENT OF THE MIDDLESEX HOSPITAL

One of the authors (G. G.-T.) has already published two contributions on the interinnomino-abdominal amputation in the columns of the British Journal of Surgery, but the completion of 21 operations in the past 23 years seems to call for a note on any modifications in technique which experience has dictated in the hope that the suggestions may be of value to others called upon to practise the amputation. An attempt has also been made to collect all the hindquarter amputations that have been performed during the 11 years that have elapsed since Philip Wiles and one of the writers (G. G.-T.) made a similar collection up to 1935. Some information is also forthcoming as to the type of case most likely to benefit by this amputation in respect of cure or material prolongation of life. In the performance of the last 10 operations the writers have had the good fortune to work together on 8 occasions, and only 2 of these 10 patients have succumbed from the amputation. Nevertheless, our own total fatality-rate is higher than that of all the published cases collected during the past 11 years which form the basis for some of the conclusions set forth in this paper. The recovery-rate of the past 10 cases (80 per cent) is some improvement on the 64 per cent recovery recorded by one of the authors (G. G.-T.) in his paper published in 1940, yet operative mortality may often be an index of a readiness to help to the utmost those suffering from a radio-resistant tumour, whom heroic surgery alone can save, and is not to be regarded as a reflection on surgical judgement or operative skill.

PERSONAL CASES (G. G.-T.)

Cases 1–5 were given in detail in the British Journal of Surgery, 1935, **22**, 672.

Case 1.—**Sarcoma of upper end of femur with involvement of innominate bone.**
Operation, July 27, 1922. Death a few hours after operation.

Case 2.—**Osteoclastoma involving whole structure of innominate bone.**
Operation, Feb. 4, 1929. Patient in excellent health 17 years later.

Case 3.—**Enormous chondrosarcoma of innominate bone, overlapping upper end of femur and extending to costal arch.**
Operation, Nov. 5, 1933. Death, October, 1938, of recurrence.

Case 4.—**Sarcoma of pelvis.**
Operation, March 3, 1934. Death after operation.

Case 5.—**Osteogenic sarcoma of upper end of femur.**
Operation, July 2, 1934. Recovery. Patient is said to have died of pneumonia less than a year after amputation. It is difficult to exclude a thoracic metastasis.

Cases 6–11 were given in some detail in the British Journal of Surgery, 1940, **27**, 643.

Case 6.—**Spindle-celled sarcoma of muscles of Scarpa's triangle.**
Operation, June, 1935. Patient alive and well more than 11 years later.

Case 7.—**Osteolytic sarcoma of iliac portion of right innominate bone; pathological fracture of acetabulum.**
Operation. Death a few hours after.

Case 8.—**Spindle-celled sarcoma of muscles of Scarpa's triangle.**
Operation. Recovery. Death, probably from recurrence, 5 years later.

Case 9.—**Sarcoma of right innominate bone.**
Operation. Recovery. Death from recurrence 6 months later.

Case 10.—**Spindle-celled sarcoma of psoas muscle.**
Amputation September, 1938. Death after operation.

Case 11.—**Chondrosarcoma of left innominate bone. Operation. Recovery.**
Operation, Aug. 19, 1939. Patient alive and free from recurrences nearly 7 years later.

Case 12.—**Myxosarcoma of ilium. Hindquarter amputation. Death from recurrence 15 weeks after operation.**
Betty H., aged 25, had sustained a fall on her back a year before admission to hospital; she had suffered pain down the back of the leg to the ankle for six months previous to admission, and had noticed a lump for three months. The swelling was about 3½ in. in diameter, hard and homogeneous, arising from the dorsum ilii just below the iliac crest; the tumour was also palpable in the left iliac fossa. A biopsy on Aug. 26, 1942, showed the growth to be "a moderately cellular spindle-cell sarcoma, in which is considerable myxomatous degeneration".

She was transferred to the Radiotherapy Department, and was under treatment from Aug. 31 to Sept. 14, 1942, but the neoplasm proved to be radio-resistant, and the pain gradually intensified to an agony.

There was no clinical or X-ray evidence of metastases; the posterior situation of the neoplasm in reference to the innominate bone was not attractive from the standpoint of surgery, but the pain and distress from which the girl was suffering determined us to perform a hindquarter amputation on Sept. 19, 1942. The operation was carried out according to the technique described fully in a previous communication (Gordon-Taylor and Wiles, 1935). The girl stood the operation remarkably well; blood-loss was minimal; there was scarcely any rise of pulse-rate or fall of blood-pressure; a pint of blood was transfused during the operation. The posterior and inward extension of the growth demanded the removal of the left ala of the sacrum in addition to the innominate bone (*Fig.* 87). Some difficulty was obtained in covering the wound with integument, the position and size of the tumour precluding the fashioning of any posterior flap.

The operation relieved the agony from which the patient had suffered, but although she was able to get up she made indifferent progress, and three months after her operation local recurrence of the neoplasm was only too apparent, and she finally succumbed from the combined effects of the growth, toxæmia, and secondary hæmorrhage 15 weeks after amputation.

FIG. 87.—*Case* 12. Specimen after hindquarter amputation; whole os innominatum and ala of sacrum are involved in the growth, the body of the ilium being replaced by a thick gelatinous mass with small areas of bone embedded in it. Sections showed a moderately cellular myxosarcoma; the sacro-iliac joint was invaded by growth.

Case 13.—**Recurrent spindle-cell sarcoma of Scarpa's triangle. Interinnomino-abdominal amputation. Death from thoracic metastasis 13 weeks after amputation.**

Captain L. P., M.C., R.A., aged 43. "Reported sick" in February, 1942, to the medical officer of his unit, complaining of pain in the medial aspect of the upper thigh. Two months elapsed before the diagnosis of a neoplasm was definitely established, and in April, 1942, a local excision of the tumour in Scarpa's triangle was performed by an able surgeon attached to a hospital of great tradition. The officer subsequently attended the radiotherapy department of that same institution for 3 weeks.

Six months later, recurrent swelling and continuous pain brought the officer again to the original surgeon and radiotherapist; a reluctant decision was given that nothing further could be done. One of the present writers (G. G.-T.) was subsequently invited to see the officer, and expressed the opinion that a hindquarter amputation might still save his life. No clinical or X-ray evidence of secondary growth was forthcoming, and accordingly on Oct. 17, 1942, a hindquarter amputation was undertaken.

OPERATION.—The operation was carried out according to the technique described fully in a previous communication; the anterior situation of the growth permitted the retention of the auricular surface and articular portion of the posterior segment of the ilium (*Fig.* 88).

The poor fellow's early convalescence was by no means uneventful, since he first developed acute dilatation of the stomach, which required a Ryle's tube; he then had pneumonia, followed by hæmaturia and urinary suppression consequent on sulphapyridine exhibition. The devoted care of Surgeon-Lieutenant John Ferguson, M.B.E., R.N.V.R., and the patient's own wonderful spirit enabled him to surmount these difficulties.

He was able to get about on crutches until 12 weeks from his operation, when two or three suspicious nodules were noticed in the neighbourhood of the scar; in two days' time these had doubled their size and number, leaving no doubt as to their sinister significance. In another two days a pleural effusion of blood-stained

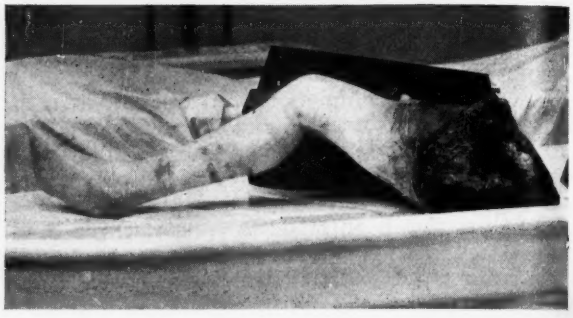


FIG. 88.—*Case* 13. Photograph of hindquarter amputation for a recurrent spindle-celled sarcoma of muscles of Scarpa's triangle.

fluid was found, and the end rapidly came, death resulting within a week of the appearance of the suspicious nodules (!) No post-mortem examination was performed. The histological appearances of the tumour were those of a spindle-celled sarcoma.

Case 14.—**Cellular spindle-celled sarcoma, possibly originating from synovial membrane. Hindquarter amputation. Death from pulmonary embolism.**

Albert B., 39, had noticed a painless swelling in the upper part of the left thigh for three months before admission to the Cambridge Hospital, Aldershot. A biopsy revealed the presence of an undifferentiated sarcoma. The patient was transferred to the Middlesex Hospital for radiotherapy, which was commenced on July 27, 1942, and the course was completed in 23 treatments spread over 30 days. On Jan. 19, 1943, there were large necrotic ulcers in the groin; a biopsy report was highly suggestive of a radio-resistant fibrosarcoma. In view of the intractable pain and the continuance of the malignant process, a hindquarter amputation was advised, and the patient was transferred to our care. The early period after operation, performed March 12, 1943, was complicated by acute sulphonamide hæmaturia, which cleared up on the administration of sodium sulphate. A few days later the patient suddenly died from what was regarded as a pulmonary embolus. No post-mortem was obtained.

Case 15.—**Spindle-celled sarcoma of ilium. Hindquarter amputation. Death.**

Percy N., aged 54. Pain in left groin on walking since July, 1942. Massage, radiant heat, and manipulation in other institutions proved unavailing. Admitted to Middlesex Hospital, March 13, 1943. Biopsy revealed the tumour to be a cellular spindle-celled sarcoma with little collagen formation. Hindquarter amputation, April 6, 1943; at operation, the growth was found to extend much farther back than was anticipated, and even to involve the bifurcation of the common iliac artery. The operation was completed not without difficulty. Death ensued six hours after.

Case 16.—**Fibrosarcoma. Hindquarter amputation. Recovery.**

A nurse between 50 and 60 years was referred to one of us (G. G.-T.) by Mr. H. L.-C. Wood, of King's

College Hospital, for a voluminous tumour on the inner aspect of the uppermost part of the thigh, bulging anteriorly and posteriorly. Biopsy showed a tumour of fibrosarcomatous type. With the able assistance of Mr. H. L.-C. Wood, a hindquarter amputation was performed in June, 1944, Dr. H. A. Richards administering an ordinary general anæsthetic of gas, oxygen, and

FIG. 89.—*Case* 16. Huge spindle-celled sarcoma of muscles of the inner aspect of the root of the left thigh; tumour bulging in the gluteal region and adductor region of the thigh. Female patient between 50 and 60 years of age. A lymphatic gland along the external iliac vessels was found to be infected with growth on examination of the specimen.

ether. The patient made a good recovery from the amputation, but unfortunately an infected gland was found along the course of the iliac vessels. The patient succumbed from pulmonary metastases four months later.

The specimen was reported by Dr. R. W. Scarff as a cellular spindle-celled sarcoma with areas suggestive of an origin in fascial sheath (*Fig.* 89).

Case 17.—**Myxochondrosarcoma arising in trochanteric region in right femur. Death from recurrence 18 months later.**

Alfred F., aged 47. For 16 months previous to admission he had complained of pain in the right buttock and "sciatica". Seven months before admission to Middlesex Hospital the sciatic nerve was stretched in another institution, but without relief; the patient was now confined to bed by the severity of the pain. A radiograph was ultimately taken, demonstrating a "mass at the upper end of the femur". After a preliminary biopsy, a hindquarter amputation was performed on Nov. 27, 1943. The patient made a good recovery from the operation, but died from local and pulmonary metastases, June 10, 1945 (*Fig.* 90).

FIG. 90.—*Case* 17. Photograph of hindquarter amputation for a myxochondrosarcoma arising in the trochanteric region of the right femur; a pathological fracture at the base of the femoral neck is present.

Case 18.—**Osteogenic sarcoma of trochanteric region of right femur. Pregnancy. Recovery.**

Doris P., aged 27. First complained of pain in right hip six months before admission to Middlesex Hospital. She was treated in several other institutions, firstly on a mistaken diagnosis of tuberculosis of the hip, and later as a sarcoma of the upper end of the femur, for which X-ray therapy was considered. The radiographic appearances of the mass (*Fig.* 91) negatived any prospective benefit from deep-ray therapy. The patient was seven months' pregnant.

It was recommended by one of us (G. G.-T.) that the pregnancy be terminated and the patient admitted to Middlesex Hospital. Biopsy showed the new growth to be an osteogenic sarcoma. Hindquarter amputation performed in Middlesex Hospital, Dec. 19, 1944 (*Fig.* 92). Patient discharged six weeks later, walking satisfactorily on crutches; wound soundly healed. Well 18 months later.

Case 19.—**Infiltrating chondroma of pubic bone. Hindquarter amputation. Recovery.**

Herbert H., 26, first noticed pain in right hip in January, 1945, and a mass was felt in the right groin and was also palpable on rectal examination. Radiographs showed the presence of a chondroma growing from the pubic ramus. The situation of the tumour and especially its proximity to the hip-joint seemed to negative the chances of total eradication of the neoplasm by any local removal, and a decision to perform a hindquarter amputation was made after mature deliberation and consultation with colleagues. Interinnomino-abdominal operation performed May 3, 1945 (*Fig.* 93). A good recovery followed, save that pains of a "phantom limb" were complained of, gradually diminishing in severity.

FIG. 91.—*Case* 18. Radiograph of osteogenic sarcoma of the neck and trochanteric region of the right femur. Seven months' pregnancy.

FIG. 92.—*Case* 18. Osteogenic sarcoma involving the neck and upper quarter of the shaft of the right femur. The patient had a seven months' pregnancy terminated before the performance of a hindquarter amputation.

FIG. 93.—*Case* 19. Right hindquarter amputation exhibiting a lobulated cartilaginous tumour, 3 in. in diameter, replacing the floor of the acetabulum and extending along the pubic bone as far as the symphysis pubis; some surviving areas of bone are visible at the centre of the growth. *Infiltrating chondroma*: tumour composed of atypical cartilage; there is no evidence of bone formation by the tumour.

Case 20.—**Myosarcoma of left thigh. Hindquarter operation. Recovery.**

Regina W., aged 52, a Polish lady, first noticed a lump about the size of a walnut in December, 1943; since then the tumour had grown steadily, but pain was only experienced on firm pressure and radiated down the back of the whole leg. In June, 1944, a biopsy showed the tumour to be a spindle-celled sarcoma originating in muscle. In July, 1944, a course of deep-ray therapy was given; 24 treatments were spread over 29 days. In March, 1945, there was a reappearance of the lump and a renewal of the pain; April and May, 1945, more X-ray therapy was administered. The tumour appeared radio-resistant, and on June 13, 1945, measured about 5 in. in diameter, and was raised about 1 in. above the surrounding skin. A consultation was held as to the desirability of an amputation at the hip-joint or a hindquarter amputation. The prospects of a thorough extirpation seemed to be brighter from the latter operation, inasmuch as there seemed to be considerable involvement of the muscles inserted into the great trochanter. Hindquarter amputation was performed, June, 1945. Recovery. The tumour was a myosarcoma; the appearances of the spindle-celled tumour suggest an origin in muscle; there are large areas of necrosis present. Patient free from recurrence a year later.

Case 21.—**Chondrosarcoma of innominate bone. Interinnomino-abdominal amputation. Recovery.**

E. K., male, aged 39, was admitted into Charing Cross Hospital under the care of Dr. Lennox R. Broster for a large tumour of the innominate bone bulging the gluteal region. The tumour was said to be growing rapidly and certainly its dimensions increased considerably during the fortnight of pre-operative investigation and preparation which preceded his amputation.

Operation, March 1, 1946, Charing Cross Hospital (G. G.-T.). Dr. L. R. Broster ably assisted; unilateral spinal and general anæsthetic administered by Dr. R. J. Clausen. The usual operation technique was followed, but the involvement of the gluteal muscles prevented the fashioning of any posterior flap, and the wound could not be entirely covered by the integument. The patient made an excellent recovery.

Dr. R. W. Scarff, of the Bland-Sutton Institute, Middlesex Hospital, reported the tumour as a chondrosarcoma.

TECHNIQUE OF THE OPERATION

This was fully described by one of us in the BRITISH JOURNAL OF SURGERY eleven years ago, and the lines of the operation have been followed pretty closely in the intervening years. In the first communication tribute was paid to the excellence of Hogarth Pringle's account of the amputation published 30 years ago in this JOURNAL; our homage to the Glasgow surgeon's work has not lessened with the passage of time.

Anæsthesia.—In 20 out of 21 amputations on which this communication has been written spinal anæsthesia has been employed in conjunction with general anæsthesia; but whereas stovaine used to be employed, a unilateral (ipsilateral) injection of 10 c.c. of 1–1500 nupercaine is now practised. Pentothal (g. $\frac{1}{4}$), nitrous oxide, oxygen, and minimal amounts of ether have been administered. In one case, despite the protest of the surgeon, *no* spinal anæsthetic was used, and the operation was completed under gas, oxygen, and ether (Dr. Hugh A. Richards). Perhaps no hindquarter amputation ever left the operation room in better condition (!) The 'spinal', then, is not a necessary adjunct, yet we find difficult to abandon a technique which has been used with a considerable measure of success for many years.

Position.—Emphasis was laid ten years ago on the most gentle care which should be taken in turning the patient; the danger from rough or excessive movement of a patient under spinal anæsthesia is not to be estimated lightly. Nowadays we carry out the iliac, inguinal, pubic, and gluteal portions of the operation with the patient much more in the true lateral position than formerly, the uppermost arm being placed in the usual kidney arm-rest. The surgeon leaning over the patient can perform all the necessary dissection, including the division of the dorsum ilii, with the subject in this position. The case is only very gently turned on to his back for the division of the symphysis pubis and the completion of the severance of the half pelvic ring and lower limb from the rest of the body. We have found that the amputation has been facilitated by dividing the dorsum ilii before the symphysis pubis, and the bone section is best done with a Gigli's saw after securing the posterior division of the internal iliac artery and a transverse division of the psoas muscle at the pelvic brim. We have usually divided the external iliac artery distal to the origin of the deep (inferior) epigastric and deep circumflex iliac arteries, so that the vascular supply of the rectus abdominis and flat muscles of the abdominal wall is not interfered with; these structures are destined for suture to the gluteal muscles, constituting a muscular stratum between parietal peritoneum and skin. Time is well spent in securing control of the posterior division of the internal iliac artery. In those cases where the position of the tumour or other circumstances render ligature of this artery impossible or only practicable after the expenditure of much time, a temporary clamp on the common iliac artery (arterial clamp, tape, etc.), as suggested to us by Basil Hume, is a most valuable procedure.

There is no need to mention the retention of a catheter during and after the operation, nor is there any necessity to stress the importance of adequate supplies of blood at hand. In many cases only a pint has been required during the actual performance of the amputation, but transfusion will certainly be required later on.

The impertinent intrusion of the anus into the field of operation during the stage of suturing the flaps called for some measure to conceal it, and the orifice is nowadays sealed off from the gaze of the operator and the spectators by means of a piece of cellophane or green protective appropriately retained in position by means of sutures.

In our hands about an hour and five to ten minutes constitutes the customary length of time to complete the operation, although we have finished in just under the hour. In the skilful hands of Professor Harry Platt, of Manchester, a much shorter time has often sufficed, but a perusal of the accounts written by others who have performed the amputation persuades us that we ourselves are not sluggards, and that anxiety to return the limbless patient to his bed must burn more fiercely in our breast than in most of those, perhaps with more ample time at their disposal, who have embarked upon the procedure.

After-treatment.—

1. Bed—sorbo mattress and water-pillow or full-length water-bed.
2. Electric cradle and blankets—warm jacket.
3. Sandbag to support hip.
4. Remove blocks from under foot of bed gradually as soon as condition permits.
5. Commence breathing exercises as soon as patient is round from anæsthetic.
6. When patient's back is receiving attention, patient must be rolled on to both sides.
7. Slide sandbag under loin to keep pressure off bottom of the wound, when patient is being turned on to the side of the amputation.
8. Remember the heel.
9. Glycerin enema on second day and thereafter on alternate days.
10. This is not a cosmetic operation; premature removal of sutures is forbidden and will lead to the dismissal of house surgeon or nurse after much obloquy.
11. First dressing may be done under pentothal, when the drain will be removed.

Table I.—DETAILS OF INTERINNOMINO-ABDOMINAL AMPUTATION RECORDED IN LITERATURE OR KNOWN TO AUTHORS SINCE 1935. (73 IN NUMBER)

SURGEON	SEX AND AGE OF PATIENT	DISEASE	RESULT OF OPERATION	REMARKS
Bailey, Hamilton (Great Northern Hospital, London (1937)	Female, 22	Periosteal sarcoma of pubic bone	Recovery	Lived 2 years after operation—died of thoracic disease (!)
Banet, V., and Nobo, P. (1936)	Male, 27	Fibrosarcoma of upper end of left femur	Recovery	Late result unknown. *Bol. Liga Cancer, Habana*, 1936, 11, 43
Brittain, H. A., Norwich, (1941)	Male	Malignant chondrosarcoma of dorsum ilii of large dimensions	Recovery	No recurrence at 4 years
Brittain, H. A., Norwich, (1945)	Female	Osteogenic sarcoma of upper third of femur with new-bone formation	Recovery	
Christmann, F. E., and Cingano, C. A.	Male, 30	Hydatid disease of pelvic bones	Recovery	Death 1 year later. *Bol. Trab. Acad. Argent. Cir.*, 19 44,28, 119.
Clarke, H. Osmond, Air-Commodore (1945)	Male	Sarcoma of abductive region	Recovery	
Davison, T. C. (1920)	Male, 70	Extensive cancer of skin of groin following burn in infancy	Recovery	Survived 7 years and no recurrence
Deitch, H. I., Bradford (1941)	Male	Chondrosarcoma of upper end of femur. Pathological fracture	Recovery	Alive and well 5 years later
Fierro, D. Fernandez (1937)	Female, middle-aged	Sarcoma of femur, with a metastasis in ilium of same side	Recovery	Patient alive several months later. *J. int. Coll. Surg.*, 1943, 6, 368
Fitzgerald, R. R., Montreal, (1936)	Male, 13	Osteogenic sarcoma of neck of femur	Recovery	*J. Bone Jt. Surg*, 1936, 18, 402
Fitzwilliams, D. C. L.	Male, 62	Rhabdomyosarcoma of vastus medialis	Recovery	Death from secondary sarcoma a few months later. *Proc. R. Soc. Med.*, 1938, 31, 548
Gersh, L. Y. (1936)	Male, 60	Sarcoma of head and neck of femur	Death from infection of wound	Secondary growths found at autopsy. *Sovet. Khir.*, 1936, 4, 681
Girdlestone, G. R., Oxford (1941)	Male, 44	Osteogenic sarcoma of ilium	Recovery	Personal communication. Alive and well 5 years later.
Ghormley, R. K., Henderson, M. S., and Lipscomb, P. R. (1943), 2 cases	Male, 56	Chondrosarcoma of innominate bone—with pathological fracture	No recurrence at 7 months	*Proc. Mayo Clin.*, 1944, 19, 193
	Male, 50	Chondroma of ilium, infiltrating acetabulum and head of femur	No recurrence at 2 months	
Gordon-Taylor, G. (1935)	Male, 17	Spindle-cell sarcoma of muscles of Scarpa's triangle	Alive and well at 10½ years	
Gordon-Taylor, G. (1936)	Female, 25	Spindle-cell sarcoma of Scarpa's triangle	Recovery	Death—probably from recurrence 5 years later
Gordon-Taylor, G. (1937)	Female, 37	Osteolytic sarcoma of iliac portion of innominate bone	Death within a few hours	A diminutive woman—only 4 st. in weight
Gordon-Taylor, G. (1938)	Male, 34	Spindle-cell sarcoma of right psoas	Death 24 hours after operation	
Gordon-Taylor, G. (1938)	Male, 14	Sarcoma of right innominate bone	Recovery	Death from recurrence in spine 6 months after operation
Gordon-Taylor, G. (1939)	Male, 26	Chondrosarcoma of left innominate bone	Recovery	Alive and well 6½ years later
Gordon-Taylor, G. (1942)	Female, 25	Moderately cellular spindle-cell sarcoma of ilium. Myxomatous degeneration	Recovery	Palliative operation. Huge local recurrence—death 4 months later
Gordon-Taylor, G. (1943)	Male, 45	Fibrosarcoma arising below inguinal ligament; ulcerated	Death	Fatal pulmonary embolism 11th day
Gordon-Taylor, G. (1942)	Male, 43	Recurrent spindle-celled sarcoma of Scarpa's triangle	Recovery	Died of rapidly-growing secondaries 3 months later
Gordon-Taylor, G. (1943)	Male, 40	Cellular spindle-cell sarcoma of muscles of left iliac fossa	Death within a few hours	
Gordon-Taylor, G. (1943)	Male, 55	Myxochondrosarcoma of neck and trochanteric region of femur	Recovery	Local and general recurrence 1 year later. Death 18 months after amputation
Gordon-Taylor, G. (1944)	Female, 60	Spindle-cell sarcoma of adductor region probably starting in fascial sheath	Recovery	Death from pulmonary metastases 4 months later

Table I.—Details of Interinnomino-abdominal Amputation Recorded in Literature or Known to Authors since 1935. (73 in Number)—*continued*

Surgeon	Sex and Age of Patient	Disease	Result of Operation	Remarks
Gordon-Taylor, G. (1944)	Female, (7 months pregnant) 23	Myxochondrosarcoma	Recovery	Alive and free from recurrence 12 months after
Gordon-Taylor, G. (1945)	Male	Infiltrating chondroma of pubic bone involving acetabulum	Recovery	Alive and free from recurrence 4 months later
Gordon-Taylor, G. (1945)	Female	Fibrosarcoma of gluteal muscles —probably starting in fascial sheath	Recovery	Free from recurrence 3 months later
Harris, C. W., and Laird, R. C. (1939)	Male, 48	Secondarily infected tuberculosis of hip	Recovery	Personal communication. Alive and well, October, 1945, walking on tilting-table prosthesis
Harris, R., Toronto (1937)	Female, 37	Osteolytic sarcoma of upper end of femur	Recovery	Died of pulmonary metastases, 1939
Harris, R., Toronto (1941)	Male, 51	Fibrosarcoma. Metastases in groin	Recovery	Died, 1943
Hume, Basil, St. Bart's. (1944)	Male, 49	Myxochondrosarcoma of pelvis	Recovery	Free from recurrence 8 months after amputation
Hume, Basil, St. Bart's.	Female, 37	Fibrosarcoma. Recurrent tumour of adductor region and attached to ischiopubic ramus	Recovery	Free from recurrence 6 months after amputation
Hume, Basil, St. Bart's. (1945)		Details not available	Recovery	
Irwin, Gordon, Newcastle-on-Tyne (1942)	Male, 20	Fibrosarcoma of ilium, 19 cm. × 12 cm.	Recovery	Recurrent tumour when amputation done. Alive and well more than 3 years after
Irwin, Gordon (1942)	Male, 29	Chondrosarcoma of ilium	Recovery	Recurrence and death 2 years later
Judin, S. S., of Moscow. 2 additional cases to that recorded in *Surg. Gynec. Obstet.*		—	2 recoveries	Personal communication
Keating, Claud, Surgeon Commander (1944)	Male	Air-raid injury	Death 72 hours after	Quoted at one of Inter-allied Conferences, Roy. Soc. Med., London
King, Don., and Steelquist, J., of Stanford Univ., San Francisco (1940)	Male, 45	Osteogenic sarcoma	Recovery	Death 6 months later from pulmonary metastases. *J. Bone Jt Surg.*, 1943, **25**, 351
King, Don, and Steelquist, J. (1940)	Male	Fibro-spindle-cell sarcoma of ilium under glutei	Recovery	Death 6 months later from pulmonary metastases
King, Don, and Steelquist, J. (1942)	Male, 51	Osteolytic osteogenic sarcoma	Recovery	No sign of recurrence at 10 months after amputation
King, Don, and Steelquist, J. (1942)	Female, 33	Huge tumour mass in iliac and trochanteric region. Ilium eroded	Recovery	No after-history
King, Don., and Steelquist, J. (1942)	Female, 50	Chondromyxosarcoma. Rapidly growing tumour	Recovery	Whole length of thigh involved. Well 6 months later
King, Don., and Steelquist, J. (1942)	Male, 24	Destructive lesion of intertrochanteric area. Recurrent tumour	Death	A palliative operation on desperately ill patient with gas-bacillus infection.
Leriche, R., and Stulz, E. (1936)	Male, 33	Chondromyxosarcoma of left thigh, with extension to pelvis	Recovery	Late history unknown. *Pr. méd.*, 1936, **44**, 65
Leriche, R., and Stulz, E. (1938)	Male, 29	Ewing's sarcoma of left femur—pathological fracture	Recovery	Late history unknown. *Mém. Acad. Chir.*, 1938, **64**, 31
Leighton, W. E., St. Louis (1935)	Male, 24	Osteochondroma of wing of right ilium	Recovery	Well 6 years later. *Arch. Surg.*, 1942, **45**, 913
Leighton, W. E. (1939)	Female, 44	Chondrosarcoma of brim of pelvis	Recovery	Death 2 months later from pulmonary metastases
Leighton, W. E. (1941)	Male, 47	Osteogenic sarcoma of left ischium involving acetabulum	Recovery	Well 9 months after amputation
McCaw, New Zealand	?	Tuberculosis	Recovery	Amputation through thigh, followed by hindquarter. Personal communication
MacCormack, St. James's Hospital, Balham, London	?	Sarcoma	Recovery	Personal communication
MacCormack	?	Sarcoma	Death	Personal communication

Table I.—DETAILS OF INTERINNOMINO-ABDOMINAL AMPUTATION RECORDED IN LITERATURE OR KNOWN TO AUTHORS SINCE 1935. (73 IN NUMBER)—*continued*

SURGEON	SEX AND AGE OF PATIENT	DISEASE	RESULT OF OPERATION	REMARKS
Messent, P. S., Adelaide (1936)	Female, 48	Myxosarcoma of innominate bone	Recovery	Death 2 months later from broncho-pneumonia (?)
Morton, John J., Rochester, N.Y. (1940)	Female, 51	Osteogenic sarcoma, chondro-type	Recovery	Death from recurrence 13 months later. *Ann. Surg.*, 1942, **115**, 628
Morton, J. J. (1941)	Male, 54	Probably a myxochondrosarcoma of upper end of femur	Recovery	Rapid recurrence. Death 20 months later from widespread secondaries
Morton, J. J. (1940)	Female, 42	Metastases from carcinoma of thyroid	Recovery	No evidence of recurrence at 17 months
Morton, J. J. (1940)	Male, 55	Chronic infective arthritis of hip. Frequent operations	Recovery	Well at 15 months and working in minor capacity
Ogilvie, W. H., Guy's (1937)	Female, middle-aged	Spindle-celled sarcoma of muscle	Recovery	Death from recurrence a few months later. *Trans. med. Soc. Lond.*, 1937, **60**, 139
Padovani, P. (1939)	Male, 18	Enormous tumour of right pelvis	Recovery	*Mém. Acad. Chir.*, 1939, **65**, 361
Pascallis, G.	Male, 44	Osteosarcoma of pelvis	Death	*Progr. méd.*, 1936, **64**, 1481
Platt, Harry (1938)	Male, 28	Highly malignant chondrosarcoma	Recovery	Death from recurrence 8 months later
Platt, Harry (1938)	Male, 29	Osteogenic sarcoma (chondrosarcoma) ischium	Recovery	Recurrence and death 9 months from amputation
Platt, Harry (1938)	Male, 36	Chondrosarcoma of ilium	Recovery	No sign of recurrence nearly 8 years after amputation
Platt, Harry (1939)	Female, 30	Extraperiosteal sarcoma ilium (fibrosarcomatous type). Very large tumour	Recovery	No sign of recurrence at 7 years after amputation
Platt, Harry	Male, 53	Osteogenic sarcoma ascending pubic ramus. Pelvis site of widespread Paget's disease	Recovery	Death from recurrence 3 months from amputation
Platt, Harry	Male, 41	Osteogenic sarcoma of pelvis	Death 11 days after operation	
Rapant, Vlad (1938) (Bruhn)	Male, 29	Recurrent osteolytic sarcoma of upper third of femur	Recovery	Rapid recurrence in ilium a month after. Death. *Chirurg.*, 1938, **10**, 804
Rapant, Vlad (1938)	Male, 14	Osteolytic sarcoma of femur	Recovery	After-history unknown. *Chirurg.*, 1938, **10**, 804
Ricard and Clavel (1938)	Male, 36	Malignant tumour upper end of femur	Death	*Lyon chir.*, 1938, **35**, 81
Seelig, S. (1941)	Male, 20	Ewing's tumour arising from ilium	Recovery	Death about 2 months after amputation from recurrence. *J. Bone Jt Surg.*, 1941, **23**, 929
Shvarts, Y. E. (1938)	—	Periosteal sarcoma of left hip	Death	Re-activation of old pulmonary tuberculosis and septicæmia from local necrosis. *Vestnik. Khir.*, 1938, **55**, 57
Turner, G. Grey (1938)	Female, 31	Recurrent chondroma originating in left ilium	Recovery	Local recurrence 4 years later. Well 7 years after amputation
Turner, G. Grey (1941)	Male, 49	Recurrent chondrosarcoma of antero-internal aspect of ilium (left)	Recovery	Patient had Paget's disease of lower spine and pelvis. Recurrence. Death 2½ years after amputation
Turner, G. Grey (1944)	Female, 38	Extensive tuberculosis of hip-joint. Anæmia and lardaceous disease	Recovery	1 year later making progress, but not quite healed
Warwick, W. Turner (1945), Middlesex	Male	Osteolytic sarcoma	Recovery	
Whittaker, A. H., and Sobin, D. J. (1941)	Male, 40	Spindle-cell sarcoma of right thigh	Recovery	Death 6 months later of intracranial metastases. *Ann. Surg.*, 1942, **115**, 435
White, R. G., of S. Rhodesia (1944)	Male, 55	Large fungating melanoma of leg 9 in. × 6 in. Large glands in groin and iliac fossa	Death	Private communication
Wiles, Philip		Infective osteomyelitis of innominate bone with multiple sinuses	Death	Private communication

12. Plenty of firm elastoplast to support the wound.

13. Binder to hold dressing on top, when it is necessary to re-pack.

14. Sulphamezathine, 4 g. statim, and 2 g. four-hourly up to 40 g., may sometimes be considered wise.

To our anæsthetist colleagues who have devoted their time, experience and skill to aid us we are under a deep debt of obligation. Our former colleague, Raymond Apperly, has pride of place in the number of hindquarter amputations (5) at which he has assisted; A. E. W. Idris has officiated on four occasions, H. P. Crampton and Brian Sellick each three times; F. W. Roberts and A. J. H. Hewer, each twice, and Hugh A. Richards, of King's College, and R. J. Clausen, M.C., of Charing Cross Hospital, at one ablation each.

To our ward sisters our gratitude is immense, and if the name of Miss Exley is specially mentioned, the number of cases that she has nursed far exceeds that of any of our other nursing colleagues, and much of the after-treatment now in vogue for these patients has emanated from her experience. The Theatre Sister-Superintendent at "Middlesex", Miss Thomas, G.C., has actively presided over nearly every amputation, and has proved a great surgical ally.

SUMMARY

1. The operative recovery-rate in 21 personal cases of hindquarter amputation (G. G.-T.) has been 71 per cent.

2. The operative recovery-rate of the last 10 hindquarter amputations performed by the two authors has been 80 per cent.

3. The operative recovery-rate in 80 cases collected from the literature or by private communication has been 82 per cent—a remarkable improvement on the 40 per cent recorded for all cases operated on up to 1935.

4. Final prognosis is most favourable in the infiltrating chondroma or chondrosarcoma, some cases being free from recurrence nearly 10 years after amputation.

5. Several other tumours of differing histology have remained well for considerable periods; e.g., Girdlestone's osteogenic sarcoma of the ilium (5 years), Harry Platt's extraperiosteal sarcoma of the ilium (7 years), Gordon-Taylor's spindle-cell sarcoma of muscles of the upper thigh (11 years) and his diffuse osteoclastoma of the innominate bone (17 years), and Davison's carcinoma of the skin of the groin (7 years).

Our best thanks are due to surgical friends and colleagues who have honoured us by transferring cases to our care where this form of amputation has seemed a probable line of treatment or who have kept us informed of their own operations. We are also deeply indebted to Professor Brian Windeyer who has given us of his wide experience and learning; and to Dr. R. W. Scarff, of the Bland-Sutton Institute, our debt is immense. Our old dresser, R. Graham White, of Rhodesia, has spared no pains to keep us informed of any additions to the literature of the subject.

Those who have been wholly immersed in the surgery of the recent war will have little difficulty in recognizing the beautiful artistic work of Mrs. C. G. True and of Mr. P. G. Hennell. We are also under a deep obligation to our friend and colleague, Dr. C. P. Smith, who is responsible for *Fig.* 87.

REFERENCES

ASSALI, J., and SOHIER, H. (1937), *J. Chir.*, **50**, 310.
BANET, V., and NOBO, P. (1936), *Bol. Liga Cancer., Habana*, **11**, 43.
BRITTAIN, H. A. (of Norwich), personal communication.
DAVISON, T. C. (1942), *Ann. Surg.*, **115**, 646.
FIERRO, D. FERNANDEZ (1943), *J. int. Coll. Surg.*, **6**, 368.
FITZGERALD, R. R. (1936), *J. Bone Jt Surg.*, **18**, 402.
FITZWILLIAMS, D. C. L. (1938), *Proc. R. Soc. Med.*, **31**, 548.
GERSH, L. Y. (1936), *Sovet. Khir.*, **4**, 681.
GIRDLESTONE, G. R. (of Oxford), personal communication.
GORDON-TAYLOR, G. (1940), *Brit. J. Surg.*, **27**, 643.
— — and WILES, P. (1935), *Ibid.*, **22**, 671.
HARRIS, R. I. (of Toronto), personal communication.
IRWIN, GORDON (of Newcastle) (1942), personal communication.
LERICHE, R., and STULZ, E. (1936), *Pr. méd.*, **44**, 65.
MCCAW (of Auckland, N. Z.), personal communication.
MORTON, J. J. (1942), *Ann. Surg.*, **115**, 628.
OGILVIE, W. H. (1937), *Trans. Med. Soc. Lond.*, **60**, 139.
PADOVANI, P. (1939), *Mém. Acad. Chir.*, **65**, 361.
PASCALIS, G. (1936), *Progr. méd.*, **64**, 1481.
PLATT, HARRY (1943), personal communication.
RAPANT, V. (1938), *Chirurg*, **10**, 804.
RICARD and CLAVEL (1938), *Lyon chir.*, **35**, 81.
SELIG, S. (1941), *J. Bone Jt Surg.*, **23**, 929.
SHVARTS, Y. E. (1938), *Vestnik. Khir.*, **55**, 57.
TURNER, G. GREY (1941), *Proc. R. Soc. Med.*, **34**, 562, and personal communication.
WHITTAKER, A. H., and SOBIN, D. J. (1942), *Ann. Surg.*, **115**, 435.
— — — — (1942), *Industr. med.*, **11**, 1.

A DISCUSSION ON THE TREATMENT OF INJURIES TO THE HAND

By F. T. MOORE, O.B.E.

THE QUEEN VICTORIA HOSPITAL, PLASTIC SURGERY AND JAW INJURIES CENTRE, EAST GRINSTEAD

In this mechanical age the manual worker may, from the very nature of his work, injure his hands. With increasing mechanization these injuries will become more numerous, and many of these disabled patients will become subjects for compensation. Accidents to the hands head the list of industrial injuries, with their consequent loss of man-hours. This paper attempts to discuss severe injuries of the kind which ultimately need some degree of reconstruction.

It is a fair criticism that of all injuries those to the hands are probably the worst treated, and at any reconstructive surgical Out-patients' Department numerous examples of the badly-treated injured hand can be seen. Many justifiable excuses can be advanced for this situation when compared with other branches of surgery. The surgical treatment of an injured hand is a highly specialized job, involving the use of a specialized technique and tools. The general surgeon, besides being ill-equipped in every way to deal with such cases, cannot afford the time to carry out a series of operations which are tedious, lengthy, and which only too often finally disappoint both him and his patient. At present all hand injuries cannot be absorbed into specialized centres, but a clear conception of the principles of treatment of the badly injured hand would do much to improve this neglected branch of surgery.

GENERAL CONSIDERATIONS

It is a mistake to believe that the reconstruction of a hand takes place in the operating theatre. First, as accurate a diagnosis as is possible is made from an examination of the hand, which should include radiographs. Accurate note-taking, even if brief, is essential. In a difficult hand, a complete examination with records may take an hour or more. Only by attention to detail at the beginning of treatment can the surgeon hope to arrive at a successful conclusion. The age of the patient and his work and its significance should be considered. The position of the fingers will depend on the functional diagnosis. Therefore the treatment will differ for the artisan, clerk, and mannequin. For example, the semi-flexed first interphalangeal joint of the fifth finger may encumber the artisan, be satisfactory for a clerk, yet unsightly for the mannequin. The artisan requires primarily a fully functioning hand, the cosmetic appearance of which is of secondary importance, but the mannequin requires a hand in which the cosmetic appearance may be more important than the functional result. It will mean that as long as the hands are part of the show piece, treatment will be directed to that end. If destruction of the joints of the fingers has occurred, for instance, ankylosis in full extension may be indicated. The clerk requires treatment that takes into consideration both the functional and cosmetic result. The patients' hobbies and athletic tendencies must be given consideration. Whilst the reconstructed hand may satisfy the patient in relation to his daily work, the fact that he is unable to continue, for example, his golf, may seriously influence his opinion of the result. The history must make a careful note of the many aspects of the patient's social life which will modify the planned treatment. What the patient actually complains of, in relation to his daily work, is probably the most significant fact gleaned from the whole mass of information. Failure to pay attention to this simple fact will inevitably disappoint the patient in his final result. Frequently, an accurate prognosis of the final functional result cannot be given until the surgical reconstruction of a hand is approaching finality. This fact must be made clear to a patient who is expected to undergo a series of tedious operations. Concomitant infections, such as rheumatoid arthritis, will considerably modify any attempted repair. A definite plan of treatment must be evolved. Even if allowances are made for the vast differences of opinion which quite justifiably exist, without a predetermined plan little chance of success is possible.

The operative repair of hand lesions involves a detailed knowledge of normal anatomy. It is not enough to rely on the dim memory of anatomy learnt many years before. The intimate association of nerves, tendons and their sheaths, blood-vessels, and fascial planes and spaces renders many of them liable to injury at the same time. Frequently such post-traumatic hands are seen with the palm congealed in a mass of scar tissue. If the normal anatomy is not known it is quite impossible to recognize the real nature of the lesion with even the least chance of affecting the best repair. If, for instance, the anatomy of the metacarpophalangeal and interphalangeal joints and the extensor expansions was well understood, advocates of prolonged immobilization for hand injuries would considerably modify their views.

It is necessary to complete the skin repair first, before attempting reconstruction of the deeper structures. It is impossible to operate through dense scar where muscles, tendons, and nerves are infiltrated with resolving fibrosis. Even when resolution is complete, hands involved in deep cicatrix frequently show a deficient nutrition characterized by the shiny colour and atrophic texture of the skin, and this will not improve until all scar is resected and a good skin covering supplied. The scar is usually far more extensive than clinical examination reveals. The rate of recovery varies, and whilst in some it may occur in six to eight weeks, in others it may take as many months. There are no rules for the rate of resolution of fibrous tissue in these cases and each must be treated on its merits.

Joints must be mobilized before tendon repair is undertaken. It is pointless to undertake extensive tendon grafting and suture if the joints are stiff or involved in scar. Again, an arthroplasty must not

be combined with a tendon repair of the same joint because the post-operative treatment of each is completely diverse.

Nerve repair must be carried out before tendon repair is contemplated. A successful tendon suture to an anæsthetic finger loses point because the individual will not use it. An anæsthetic thumb or finger gets in the way and suffers repeated minor damage unknown to the patient. It undergoes atrophy involving all structures. The nails become brittle, the skin dry and smooth, and the joints stiff. Accurate nerve suture offers a good prognosis for digital nerves, and this is particularly true if immediate suture is carried out should a nerve be accidentally divided during a dissection on the hand.

Post-operative splinting is frequently necessary and as a general rule volar splints for dorsal lesions and dorsal splints for volar lesions should be used. All joints should be immobilized in the position of physiological rest unless the operative procedure or the lesion demands otherwise. The fingers at rest assume a position midway between the limits of flexion and extension of each joint, and the thumb is partially opposed with its joints similarly semi-flexed. The wrist-joint is also dorsiflexed to about 20°, with 10° of ulnar deviation. The ability of the thumb to oppose the tip of the index or middle finger cannot be over-emphasized, and even though only a minimum of motion of the fingers and thumb is obtained, the patient will have immediately a useful hand for gross purposes.

Only that part of the hand which is involved in the operative procedure should be immobilized. There are many enthusiasts for Trueta's closed unpadded plaster for the treatment of hand injuries. Whilst the plaster cast has its place in war-time for the temporary treatment of some injuries, as far as fingers are concerned, prolonged immobilization is disastrous. Trueta's method applied to the fingers in burns, for instance, has not been a contribution to surgical progress. The commonest cause of a stiff hand in burns is prolonged immobilization; in traumatic lesions, sepsis. As soon as the clinical condition and dictates of the treatment of the wound permit, active movements should be begun if early restoration of function is to be obtained. The importance of physiotherapy, which includes short-wave and infra-red treatment, wax baths, and massage, cannot be over-estimated, but it must be emphasized that active movements will replace hours of passive treatment. Splints designed to increase range of movement by prolonged traction are useful adjuncts to treatment (*Fig.* 94). Such splints, particularly if worn at nights, but in no way replacing active movements, will naturally assist in treatment. Coarse movements recover first, and it may be many months before fine co-ordinated movement is possible. Treatment should be aimed at the re-education of the fine movements. Movement is the result of co-ordination of the action of several muscles and tendons. Even a simple voluntary movement—for instance, clenching the fist—requires the contraction of the flexor group of muscles or the prime movers, and elongation of the extensor muscles or antagonists. The extensor group of muscles in this case are also synergists and fix the wrist-joint. The synergic or stabilizing action of the lumbricals and interossei on the metacarpophalangeal joints, for example, permits the long extensor muscles to extend the distal two joints of the finger. Co-ordination between prime movers, antagonists, and synergists is soon lost, and treatment should be aimed at the re-education of these movements. The assembly of small mechanical apparatus, such as Meccano, is excellent. The exercises involved begin with the simple models and progress to the more difficult, so that automatic, rhythmic, and repeated movements are carried out, entirely divorced from mental concentration. Whilst it is invaluable to re-educate and co-ordinate hand movements, it is also interesting, and the patient will tend to adhere to such a method of treatment. The intelligent co-operative patient will recover full function many weeks before the duller and more unco-operative type. The progress of a stiff hand is largely dependent on the patient himself. The short time which he can spend in a physio-therapy department should be directed to the type of treatment which he himself must undertake during the remainder of the day. It is here that industrial therapy can play such a vital part in this essential period of the regulated treatment. At this Unit a sub-branch of an aircraft component assembly shop was established, and every patient with a lesion involving the fingers was directed to this department twice during the day, each period lasting two hours. The exercises or jobs were graduated so that the successful accomplishment of an exercise provided the groundwork or training for the forthcoming more difficult exercise. These exercises were sufficiently easy to permit patients to carry on normal conversation while working, and therefore perform a series of co-ordinated, rhythmic, automatic finger movements subconsciously.

FIG. 94.—Photograph to illustrate the type of splint used at this Unit to increase range of movement by prolonged traction, the traction being provided by elastic bands.

The common mistakes in the surgical treatment of hand lesions are :—

1. *Sepsis.*—Sepsis is still the commonest cause of stiff hands. Untreated and badly treated cases contribute to the large number of cases that require some degree of reconstruction. Extensive infections resolve by fibrosis leading to compression of blood-vessels, lymphatics, and nerves, with ensuing trophic

changes, ankylosis of joints, and contraction of muscles, while adhesions about the tendons or their destruction adds to the disability. At operation, in those cases in which tendon-sheaths have been involved, the synovial sheath is entirely obliterated and there is complete fibrous union between the tendon and its sheath throughout its extent. In the majority of cases the tendons are indistinguishable as tendons from the surrounding connective tissue. The most unfortunate sequelæ, however, is that produced in the lumbricals and interossei, which may be entirely destroyed. The clinical appearance in its worst form is the ' frozen ' hand. Early diagnosis and drainage by correct incisions, combined with adequate chemotherapy, particularly penicillin, should banish these crippled hands from hospital wards.

2. Prolonged immobilization, frequently in faulty position, will cause unnecessary loss of finger movement. In addition to intra- and periarticular adhesions and wasting of intrinsic muscles, shortening takes place in tendons and the neurovascular bundle. If the immobilization is prolonged, that part of the articular surface not actually in contact with its opposing articular cartilage atrophies and finally disappears. The remaining articular cartilage gradually adapts itself intrinsically to the shape of the opposing surface. This process is accompanied by shortening of the joint capsule and collateral ligaments, successfully anchoring the joints in this position (*Fig.* 95). It is quite impossible to restore

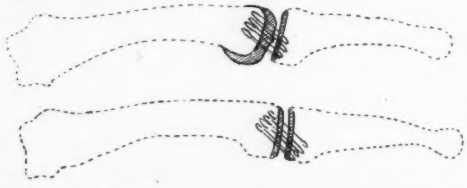


FIG. 95.—Diagram to illustrate the articular surfaces and collateral ligaments of a joint of the finger before and after prolonged immobilization.

full function under these conditions, but active movements, as produced by industrial therapy, combined with intensive physiotherapy, will salvage what remnants of movement are possible.

3. Forcible manipulation of joints under general anæsthesia is absolutely contra-indicated. Whilst a full range of movement can be attained immediately, the final result is always worse. This is easily understood if the pathology and anatomy of these complex joints is understood. Forcible flexion of a metacarpophalangeal or interphalangeal joint will tear the collateral ligaments and cause rents in the capsule. Subsequent post-manipulative pain prevents early movement and the lesion heals by scar tissue and the joint will become even stiffer. Gradual increase in movement is only obtained by concentration on directed active movements and splints designed to apply sustained traction to maintain the favourable position gained. All other physiotherapeutic measures are only adjuncts to treatment.

4. Raw areas on the hands must not be allowed to heal by granulation but should be covered with skin as soon as possible. This is particularly true where tendons are exposed. The fibrosis that accompanies the healing of raw areas by granulation involves the deeper structures to a greater or lesser degree. The scar will subsequently contract and will require a major procedure to correct. Infected granulation tissue will convert a superficial lesion into a deeper lesion which may involve tendons and joints. With adequate chemotherapy it is essential to convert open wounds into closed wounds by covering them with skin immediately. Only by such means can healing occur rapidly, and thus the damage caused be reduced.

5. Operative procedures on the hands must be carried out in a bloodless field secured with a pneumatic type of tourniquet. It is impossible to dissect among the closely packed tendons and nerves in a field swimming in blood. A clear demonstration of anatomical details and identification of each structure is a necessity, particularly if the operative field is involved in scar tissue. Prolonged ischæmia of a hand already suffering from deficient nutrition is obviously not desired, but the clarity of a bloodless field far outweighs the damage that can easily be inflicted whilst blindly dissecting in a palm, the field obscured by blood. On the other hand, it has been argued that the ischæmia produced by tourniquets will induce a generalized tissue reaction, as indicated by delayed healing and prolonged residual stiffness in a previously mobile hand. In this unit only the pneumatic type of tourniquet is used. Even when occlusion is maintained for as long as 2½ hours nerve lesions have not been observed. This degree of safety cannot be claimed for such tourniquets as the Esmarch type. The tourniquet should be released for 5–10 minutes every hour. Immediately on releasing the tourniquet, blood floods the wound. A period of reactive hyperæmia follows, which appears within a few seconds, and is presumably due to the products of tissue activity.

These vasodilator substances affect arterioles and capillaries alike. The degree of hyperæmia is greater and more lasting as the period of occlusion is prolonged. This period may last up to 20 minutes before hæmostasis can be satisfactorily demonstrated. Firm pressure with warm packs will help to reduce capillary ooze. All bleeding points are secured, great care being taken not to nip nerves which pursue a path proximal to the arterial system. Finally, the raw area is swabbed with fibrin foam, and/or fibrinogen and prothrombin added to the oozing area. To secure satisfactory hæmostasis may take as long as the actual constructive operation in question, but is just as important. Failure to secure perfect hæmotasis following operations on the hands will destroy hours of perfect work.

Hæmatomata undergo resolution with replacement fibrosis involving the whole operative field. Tendons, nerves, blood-vessels, muscles, fascia, and skin become knitted together by scar. And weeks may elapse before function is restored. Drainage for 24–48 hours, combined with a pressure dressing to control capillary oozing without ischæmia, is essential. Much practice is needed before the correct amount of pressure is known. Twenty-four hours after operation the bandages should be loosened and re-applied at the proper degree of

pressure to accommodate the post-operative swelling which takes place. Freshly operated hands should always be elevated whilst in bed, and in a sling when ambulatory. Prolonged ischæmia will lead to necrosis and gangrene of the terminal parts of the fingers, with disastrous results. The finger tips should always be left exposed so that the circulation can be watched. Loss of a finger tip through tight bandaging is a disaster that is not easy to explain to the patient.

6. In many cases attempts at repair are carried out under unsuitable conditions, using unsuitable instruments and suture material, and good results are hoped for rather than anticipated. The surgery of the hand is a specialized job involving the use of a specialized technique and adequate facilities for post-operative treatment. Too many hands are referred to special centres only after an attempt at repair or reconstruction has already failed, thus increasing the reconstructive surgeon's difficulties and decreasing the possibility of obtaining the better result. The greatest care possible should be taken when it is necessary to handle tissues. To achieve this end special light-weight forceps of the McIndoe type are used. Fine dural hooks are used as retractors. Suture materials are of the finest black silk on atraumatic sharp needles. The mosquito pattern artery forceps, which pick up only the bleeding point, are used. Sharp instruments are maintained with a keen edge. Practically all operations are conducted with the surgeon seated, so that he is adequately relaxed. Tremor is eliminated by bracing the fingers as a fulcrum and resting the forearms on something solid. With a bloodless

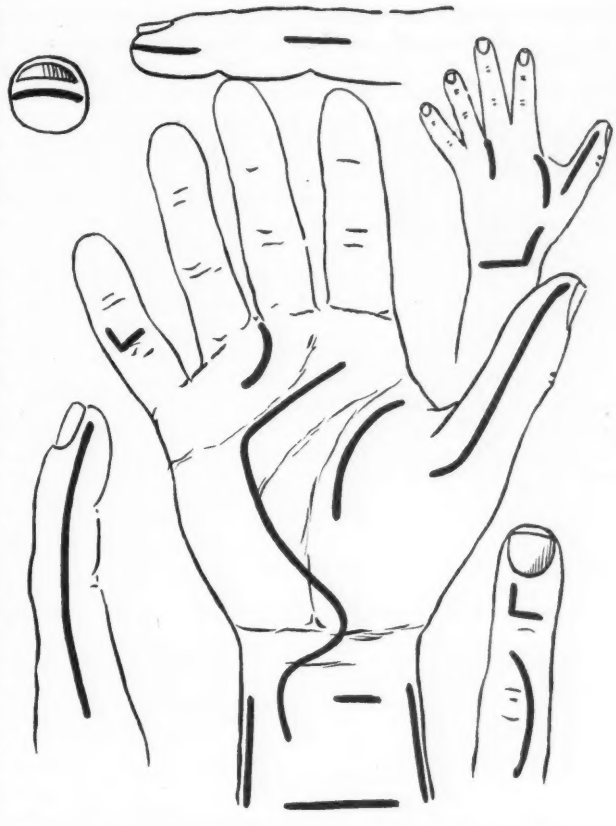


FIG. 96.—Incisions for surgery of the hand. (*After Bunnell.*)

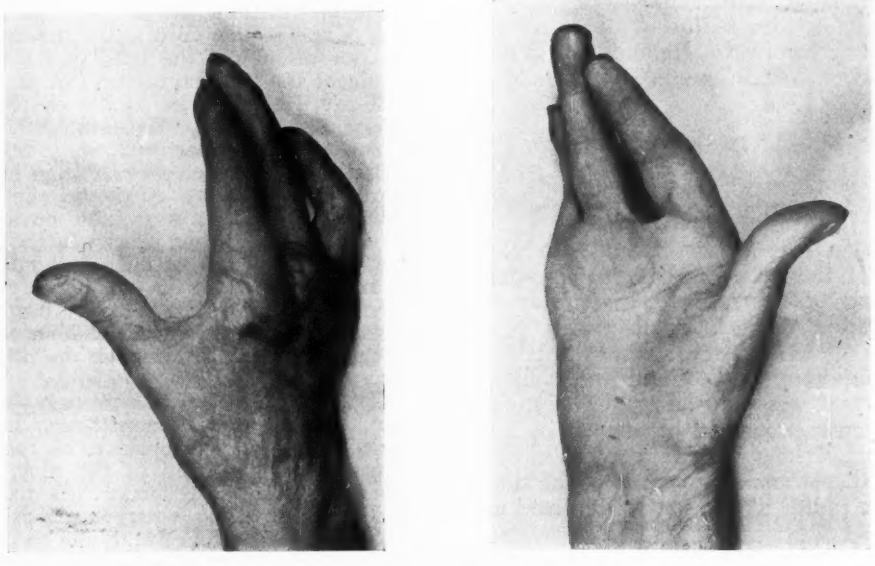


FIG. 97.—These photographs illustrate the rotation deformity of the fingers following partial resection of the metacarpal bone of the middle finger.

field, trauma produced by repeated sponging is eliminated. Only by great delicacy in handling the tissues can the ensuing tissue reaction be reduced to a minimum. It is surprising that even to-day incisions are practised that can only lead to flexion contractures. No incision in the palm of the hand should ever be made longitudinally across a joint crease. These longitudinal incisions may heal with contraction of the scar, preventing full extension of the involved joints. The worst examples are to be seen following operations for acute infections of the hand or for Dupuytren's contracture where these

incisions have been used. They are inexcusable. Koch and Kanavel probably did most work to establish the use of incisions that do least harm. Bunnell has modified these incisions and the diagram (*Fig.* 96) indicates those he recommends. It is noticeable that these incisions take into consideration the normal crease of the hand and the exposure of the underlying anatomical structures, and are almost invisible in time.

7. Attempts at tendon reconstruction through scar, or with involved joints stiff or ankylosed, is doomed to failure. Multiple injuries to a digit involving nerves, tendons, joints, and skin is an indication for amputation, not reconstruction. A single mutilated digit in a working man is best removed. A residual disability with lack of full function inevitably makes such a member a nuisance to him. The functional result of the hand is more important to him than the cosmetic appearance. Generally speaking, amputations of the index and fifth fingers should not leave a short stump, because it may get in the way. Cosmetically, an oblique removal of the corresponding metacarpal bone is good, because a single missing finger is rarely noticed. Amputations of the middle or ring finger, involving the metacarpal head, must be accompanied by resection of the corresponding metacarpal bone with reconstruction of the transverse carpal ligament. Failure to remove the metacarpal bone and collapse the hand will cause a rotation deformity of the adjoining fingers. Lack of reconstruction of the transverse metacarpal ligament will accentuate this deformity, with subsequent marked loss in function (*Fig.* 97).

I am greatly indebted to my teacher, Mr. A. H. McIndoe, C.B.E., for so much help, encouragement, and assistance in the preparation of this paper.

DISLOCATION OF THE INFERIOR RADIO-ULNAR JOINT

By J. F. CURR

TEMPORARY ASSISTANT SURGEON, ROYAL INFIRMARY, EDINBURGH, AND LEITH HOSPITAL

AND W. A. COE

TEMPORARY ASSISTANT SURGEON, ROYAL INFIRMARY, EDINBURGH

UNCOMPLICATED acute dislocations in the region of the wrist are infrequent in comparison to the well-known fractures. This paper is limited to a presentation of four cases of dislocation involving the inferior radio-ulnar joint, one case of a dislocation at both ends of the radius, and one case of dislocation of the scaphoid. Radiocarpal dislocations and the other dislocations of and around the carpal bones are omitted.

ANTERIOR AND POSTERIOR DISLOCATIONS OF THE INFERIOR RADIO-ULNAR JOINT

The dislocation may be described in terms of the movement of the head of the ulna in relation to the lower end of the radius, an anterior or a posterior dislocation being a displacement of the ulna in front of or behind the radius respectively. Of the cases reported here, three were anterior dislocations and one was a posterior. This nomenclature is in common usage and is retained, although open to criticism. It may be more correct, however, to describe the displacement in terms of the mobile lower end of the radius in relation to the fixed ulna.

CASE REPORTS

HISTORY.—One case was a young woman and three were middle-aged men. In all there was a history of a fall on the hand, associated with a considerable rotation of the rest of the limb once the hand had become fixed on the ground. Forcible pronation caused the posterior displacement and supination the anterior.

CLINICAL FEATURES.—All the injuries were of recent origin and the patients attended for treatment within twenty-four hours of the accident. Pain was outstanding and seemed to be of greater severity than in a Colles's fracture. There was almost complete loss of any movements at the wrist. The visible deformity in the anterior dislocations was very marked, a distinct dimple being present in place of the normal prominence of the head of the ulna and the breadth of the wrist being narrowed. The head of the ulna was not visible, but was palpable in front of the radius, deep to the flexor tendons. In the posterior dislocation the head of the ulna was unduly prominent and lying on the back of the radius.

X-RAY EXAMINATION (*Figs.* 98–100).—The X-ray appearances were less prominent than the clinical features, and, on a hurried glance, what was in reality a true lateral view of the dislocation was liable to be mistaken for a normal oblique view. After the clinical examination, however, the features were quite obvious. The radius and ulna were in wrong alinement, the lower end of the ulna was either in front of, or behind, the radius, and the articular notch for the ulna on the radius was empty. Three of the cases showed no fracture and one showed a crack in the radial styloid without any displacement, which was neither the cause nor the effect of the dislocation.

TREATMENT.—The same treatment was applied to all cases. Under general anæsthesia, manipulation was carried out by a combination of rotation and direct pressure over the head of the ulna, a distinct click indicating successful reduction. A dramatic relief from pain followed. The wrist was kept immobilized in plaster for three to four weeks, and by the end of another week full movements were restored, no disability ensuing.

DISCUSSION

According to Gibson (1925), on theoretical grounds, the mechanism of the dislocation might be: (*a*) A force applied in an abnormal direction so as to separate the bones or to push one past the other tangentially; or (*b*) A force applied in a normal direction but excessive in amount. Judging by the

personal cases, the essential feature of the mechanism seems to be a sudden excessive rotation combined with a longitudinal force. The inevitable result is tearing of the radio-ulnar ligaments and the triangular fibrocartilage; an alternative to the latter is an avulsion of the ulnar styloid. The pronator quadratus remains intact.

Such isolated and uncomplicated dislocations of the inferior radio-ulnar joint are rare, and Gibson (1925) remarked that few surgeons had seen more

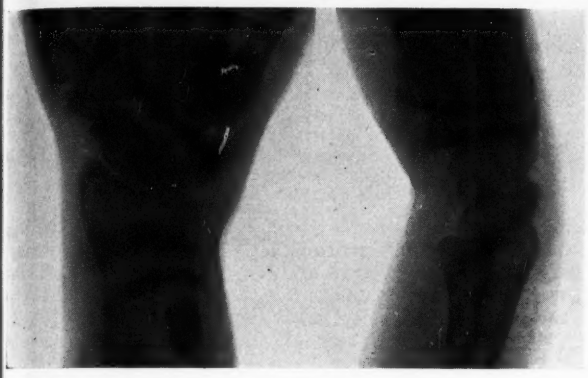


FIG. 98.—Anterior dislocation of inferior radio-ulnar joint; well-marked dimple in skin overlying head of ulna.

than one case. Cotton and Brickley (1912) knew of 27 previous cases and Cox (1942) stated that Vergoz and Choussat had collected 68 cases by 1937. A remarkable feature is that many of these were not diagnosed at first, being recognized several weeks later, by which time open operation was necessary. It is obviously desirable to diagnose the injury at once, as treatment by manipulation is easy and the subsequent result is excellent.

Distinct from this type of injury, there are other causes of the dislocation which are relatively common. As regards acute injuries, many cases of Colles's fracture and fractures of the shaft of the radius with overriding and/or angulation are associated with subluxation or dislocation of the inferior radio-ulnar joint. This type generally responds to the correct treatment of the fracture.

There is also a type of permanent or recurrent subluxation or dislocation, those cases with posterior displacement of the ulna being loosely classified as Madelung's deformity. The possible causes include: a congenital deformity; an old injury of the triangular fibro-cartilage or radio-ulnar ligaments leading to laxity of the joint; an untreated acute dislocation; malunited fractures causing axial deviation of the radius and ulna; relative shortening of the radius due to an old epiphysial injury, a previous fracture, too free excision of the upper end for a fractured head of radius, previous rickets, a destructive lesion such as osteomyelitis, tumours or bone dystrophies; chronic arthritis; enlargement of the head of the ulna.

In these chronic cases the treatment varies widely, depending on the original cause and the degree of disability. In the selected case operation may consist of excision of the lower end of the ulna, osteotomy and/or bone-grafting of the radius, or repair with fascia. Several of the chronic lesions are preventable by correct treatment of an original injury.

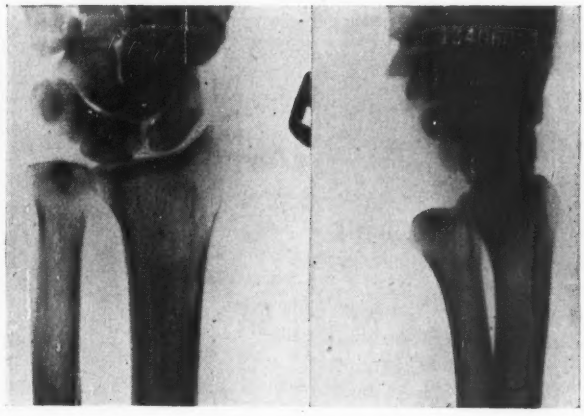


FIG. 99.—Anterior dislocation of inferior radio-ulnar joint.

FIG. 100.—Anterior dislocation of inferior radio-ulnar joint. Also crack in lower end of radius, not part of the mechanism of the dislocation.

VERTICAL DISLOCATION OF THE INFERIOR RADIO-ULNAR JOINT, ASSOCIATED WITH POSTERIOR DISLOCATION AND FRACTURE OF THE UPPER END OF THE RADIUS

CASE REPORT

HISTORY.—A young man was at work in a coal-mine, and, while the elbow was flexed at right angles, the left forearm became jammed between a moving and a stationary hutch, so that a very severe force was applied longitudinally to it.

CLINICAL FEATURES.—The patient obviously had a severe injury, causing much pain, but there was no wound in the skin. There was extreme swelling of the elbow, forearm, and wrist, movements were absent, and the hand was displaced to the radial side. The ulnar styloid was palpable distal to the radial styloid.

X-RAY EXAMINATION (*Fig.* 101).—There was a dislocation of the inferior radio-ulnar joint, with marked proximal displacement of the radius; the ulna protruded distal to the radius, and was displaced posteriorly and

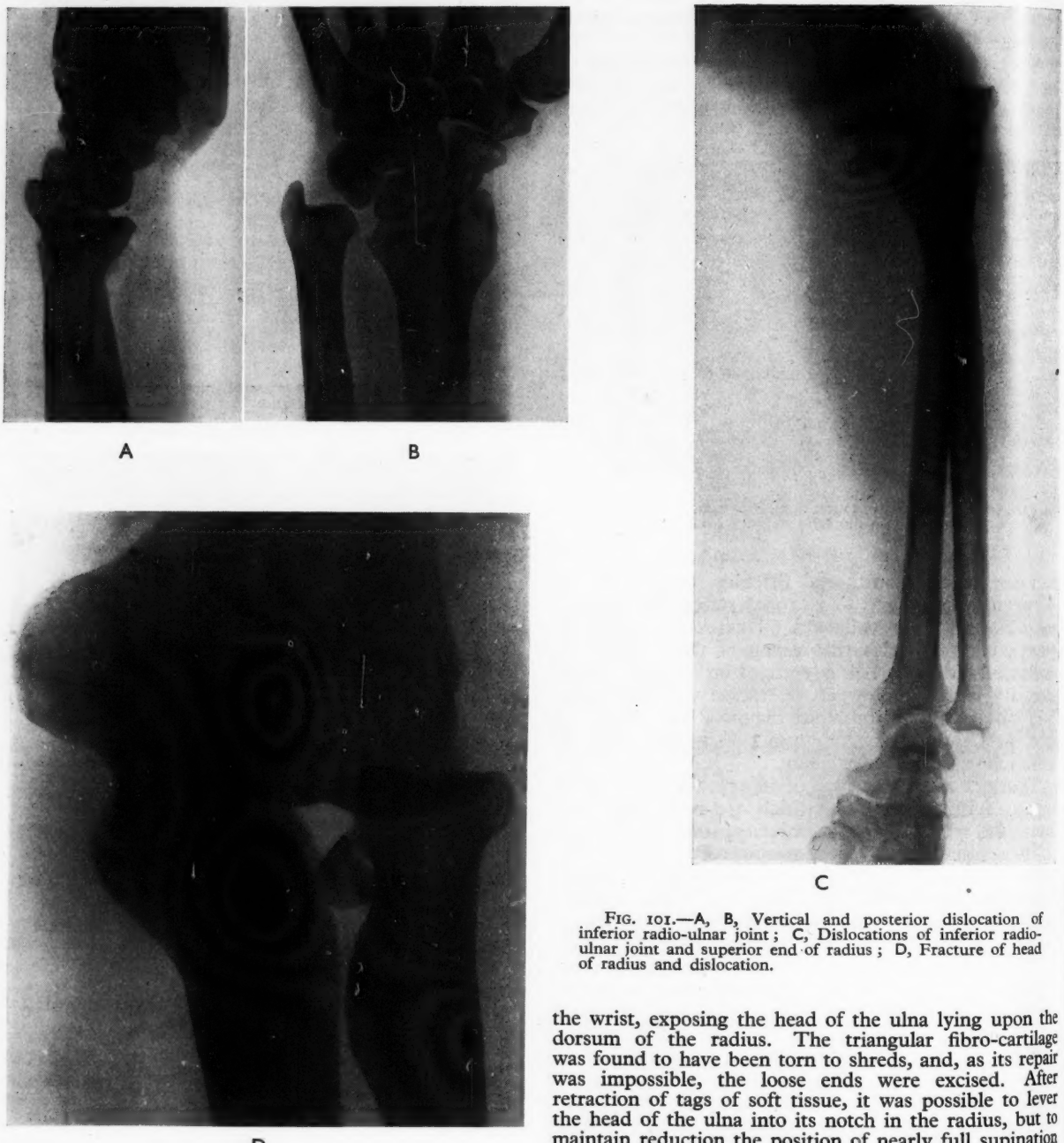


FIG. 101.—A, B, Vertical and posterior dislocation of inferior radio-ulnar joint; C, Dislocations of inferior radio-ulnar joint and superior end of radius; D, Fracture of head of radius and dislocation.

medially. The upper end of the radius was dislocated posteriorly from the elbow-joint and there was a fracture of the head of the radius, a small fragment being displaced towards the medial side.

TREATMENT.—Under general anæsthesia, manipulation was carried out three hours after the accident. By applying strong traction and direct pressure over the upper end of the radius, the proximal dislocation was easily reduced. The vertical displacement of the inferior radio-ulnar joint was thereupon corrected, but the head of the ulna remained displaced posteriorly, defying attempts at manipulation both then and also three days later.

One week after the accident an open operation was performed through a vertical incision on the dorsum of the wrist, exposing the head of the ulna lying upon the dorsum of the radius. The triangular fibro-cartilage was found to have been torn to shreds, and, as its repair was impossible, the loose ends were excised. After retraction of tags of soft tissue, it was possible to lever the head of the ulna into its notch in the radius, but to maintain reduction the position of nearly full supination was necessary. Thereafter immobilization of the elbow and wrist was maintained for six weeks, and was followed by physiotherapy.

In assessing the final result one year later, flexion and extension of the wrist and flexion of the elbow were complete, and extension of the elbow was to 150°. The forearm was in the mid position of pronation and supination, but no more than 5° of movement were possible. Further operative treatment to improve pronation and supination was not contemplated, as excision of either the head of the radius or the lower end of the ulna alone would not be sufficient, whereas excision of both would tend to instability of the forearm.

DISCUSSION

A complex injury of this nature has not apparently been reported previously. Gibson (1925), in discussing inferior radio-ulnar dislocations, stated that forcible distraction of the bones was probably of theoretical interest only, and he was unable to find a reference. In the case reported, the longitudinal force applied to the forearm probably caused first a fracture and then a dislocation of the upper end of the radius. Only then was it possible for the vertical dislocation to take place at the inferior radio-ulnar joint. In addition to the features already mentioned, there was a disruption of the superior radio-ulnar joint, and the interosseous membrane was bound to have been severely torn. In view of the multiplicity of the injuries, the final result could be considered quite satisfactory.

DISLOCATION OF THE SCAPHOID

CASE REPORT

HISTORY.—A young man employed in building construction found himself threatened by a heavy metal girder which was being lifted by a crane and was swinging out of control. To save himself, he pushed it away forcibly with the outstretched left hand and at once experienced severe pain in the wrist.

CLINICAL FEATURES.—Swelling and tenderness were marked over the scaphoid, but there was no particularly distinctive feature. Considerable disability was present.

X-RAY EXAMINATION (*Fig.* 102).—No fracture was present. The proximal end of the scaphoid was completely dislocated from the radius and lunate and was directed anteriorly, having been tilted through about 80°. The distal end of the scaphoid remained in contact with the trapezium. The lunate appeared to be slightly displaced towards the ulnar side.

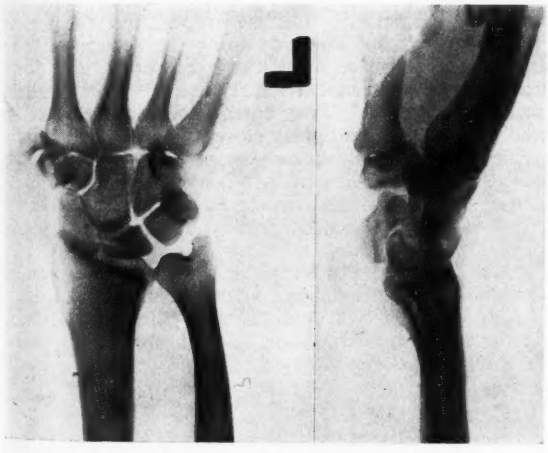


FIG. 102.—Dislocation of scaphoid, with anterior displacement of proximal end.

TREATMENT.—Under general anæsthesia, manipulation was performed twenty-four hours after the accident. By means of strong traction on the thumb and index finger and direct pressure on the proximal end of the scaphoid, reduction of the deformity was accompanied by a distinct snap. X-ray examination, however, showed that the scaphoid and lunate were not perfectly approximated, so that a second manipulation was required three days later, complete reduction then being obtained. The wrist was immobilized in plaster for six weeks, but recovery of function was slow thereafter. Ultimately, after four months, dorsiflexion and palmar flexion of the wrist were restored to three-quarters of the normal range, movement being quite painless. The grip was strong and thumb movements were complete.

DISCUSSION

This is a very rare carpal injury and few cases have been reported. Buzby (1934) recorded a case where the scaphoid was rotated to the lateral side and the proximal end was tilted anteriorly; manipulative reduction was successful. In the case reported by Walker (1943) the proximal end of the scaphoid was completely tilted laterally, whereas in the case treated by Watson-Jones (1944) the proximal end was lying behind the radius and the tubercle was prominent in the palm; operative reduction was necessary in both. There is thus no uniformity in the direction in which the dislocation may take place. In an anterior dislocation the mechanism appears to be a forcible dorsiflexion of the wrist combined with an excessive rotatory strain; in the posterior dislocation acute hyperflexion of the wrist may be the cause.

SUMMARY

1. Four cases are reported of dislocation of the inferior radio-ulnar joint, three with anterior displacement of the ulna and one with posterior displacement. Manipulative reduction was successful. Other causes of such dislocations are reviewed.

2. A complex forearm injury is described, with dislocation of the inferior radio-ulnar joint and of the upper end of the radius, along with a fracture of the latter. Operative reduction was necessary for the wrist lesion.

3. A dislocation of the scaphoid was successfully treated by manipulative reduction.

We wish to thank Dr. R. McWhirter and Dr. J. G. Kininmonth for the radiological examinations.

REFERENCES

BUZBY, B. F. (1934), *Ann. Surg.*, **100**, 553.
COTTON, F. J., and BRICKLEY, W. J. (1912), *Ibid.*, **55**, 368.
COX, F. J. (1942), *Surgery*, **12**, 41.
GIBSON, A. (1925), *J. Bone Jt Surg.*, **7**, 180.
WALKER, G. B. W. (1943), *Brit. J. Surg.*, **30**, 380.
WATSON-JONES, SIR R. (1944), *Fractures and other Bone and Joint Injuries*, 3rd. ed., **2**, 575. Edinburgh: E. & S. Livingstone.

A CASE OF ACUTE ANAEROBIC STREPTOCOCCAL INFECTION OF THE NECK OF DENTAL ORIGIN

By Major C. GEOFFREY BOOTHROYD, A. D. Corps, M.E.F.
and Lieut.-Col. CAMERON MACLEOD, R.A.M.C., M.E.F.

The incidence of acute spreading cellulitis of the neck, of dental origin, is fortunately uncommon. The following case is deemed worthy of record for two reasons: first, to illustrate the speed with which a streptococcal infection may progress to a fatal termination when once the process has spread beyond the barrier of the mylohyoid muscles; and, secondly, because at the autopsy the authors were fortunate in obtaining specimens and evidence indicative of the course of events.

CASE REPORT

History.—Some eight months prior to the onset of his final illness, the patient, a well-developed male of 34, had complained of thermal sensitivity in $\overline{/7}$ region. A dressing was inserted in the tooth and this symptom subsided, until a "slight toothache" occurred three days prior to his admission. The following day, pain became acute in the region of the left angle of the mandible and a pyrexia developed. Thereafter his condition became progressively worse, and treatment was supplemented by the administration of M & B 693, until he was admitted to hospital at midday on Feb. 22, 1945.

On Admission.—The clinical dental state was fair. $\overline{/568}$ were missing from the left mandible. The crown of $\overline{/7}$ was abraded to within one millimetre of the gingival margins, the coronal surface being covered with temporary cement. The tooth did not react to thermal tests, and was only mildly tender to percussion. There was no inflammation of the soft tissues in its immediate proximity. Trismus was present, but was not sufficiently marked to interfere with intra-oral examination. The floor of the mouth was indurated, and the tongue could not be protruded. The clinical dental picture remained unchanged throughout.

The general condition was very poor. Temperature 102°; pulse 110 and irregular; respirations 24. Colour of face ashen-grey. Dysphagia was extreme, and an irritable cough persisted, with expectoration of much frothy mucus. There was a generalized brawny swelling of the neck, extending from sternomastoid to sternomastoid, and from mandible to manubrium sterni, with some œdema superficial to the latter. The larynx and trachea appeared to be displaced forward. Pitting œdema of the skin was present in the left anterior triangle of the neck, but no definite fluctuation could be detected. X-ray examination revealed an unerupted third molar lying vertically, with areas of apical osteitis in relation to the mesial and distal roots of $\overline{/7}$ and the distal root of $\overline{/8}$.

Treatment.—Parenteral penicillin, initial dose of 20,000 units immediately on admission, followed by 15,000 units three-hourly. Antiphlogistine to neck. Hot mouthwashes (sodii sulph. in flavine).

Progress.—Temperature fluctuated between 102° and 103·4°, with a pulse-rate rising to a maximum of 128 in the early hours of Feb. 23. Respirations varied between 22 and 23. The patient passed a poor night, expectorating mucopus in quantity. Blood-count, W.B.C. 15,800 per c.mm.; polymorphs 90 per cent, lymphocytes 8 per cent, mononuclears 2 per cent.

The general condition continued to deteriorate during the day, and the dysphagia became complete. Radiographs of the neck taken at this stage disclosed an ill-defined soft-tissue swelling extending as far down as the manubrium sterni, and lateral views showed a definite increase in the post-cricoid space. No abnormality was shown in the lungs. Intramuscular penicillin was continued with no apparent response. Culture taken from the $\overline{/8}$ region showed a light growth of hæmolytic streptococci, and a moderate growth of *Staph. aureus*, the combined penicillin sensitivity factor being 0·4.

On examination of the neck in the afternoon, a doubtful area of fluctuation was detected in the left anterior triangle, in the area where œdema had been previously noted. The opinion of the medical specialist having been previously obtained regarding the heart, and in consultation with the anæsthetist, operation was decided upon, if not to find pus, to relieve tension under the deep cervical fascia, and thus relieve the urgent dysphagia.

Hyoscine (gr. 1/150) and avertin were administered at 18.30 hr.

Operation, 19.00 hr., Feb. 23 (Lt.-Col. Cameron MacLeod).—Endotracheal gas and oxygen (Major J. F. Bereen, R.A.M.C.). The tracheal tube was passed with ease. An incision was made along the anterior border of the left sternomastoid muscle. There was much œdema of the subcutaneous tissues. On aspiration, thin offensive pus in small quantity was obtained. The deep fascia was then incised. Diffuse suppuration was present. A finger was passed upwards along the separated tissue planes as far as the cornu of the hyoid bone, and downwards to the sternoclavicular joint. No localizing abscess was found. Two corrugated drains were inserted and the wound lightly closed.

The patient's condition was critical on return to the ward at 19.35 hr. Penicillin was continued until 22.00 hr., the total amount administered being 185,000 units. He did not recover consciousness, and died at 00.15 hr. on Feb. 24.

Examination of fluid aspirated from neck at operation: 1 c.c. of blood-stained, watery pus. Direct film—moderate number of pus cells. Numerous Gram-positive cocci and bacilli of varying shapes and sizes, with a few Gram-negative bacilli.

Culture: Aerobic { Hæmolytic streptococci, moderate growth. / Coliform bacilli, slight growth.
Anaerobic { Hæmolytic streptococci, heavy growth. / Coliform bacilli, slight growth.

Penicillin sensitivity factor of hæmolytic streptococci = 0·5.

At Autopsy (Major A. D. Morgan, R.A.M.C.).—The whole of the soft tissues covering the front of the neck were generally swollen with œdema from the mandible to the manubrium sterni. The pharyngeal wall itself was swollen, but there was no œdema of the glottis. The left mylohyoid muscle was swollen and necrotic, and contained a small abscess. On the inner aspect of the mandible, just below the left mylohyoid ridge, was an area of bone, denuded of periosteum, in the centre of which was a small opening 1 mm. in diameter (*Fig.* 103) which proved to be a sinus leading to a localized abscess at the root of $\overline{/7}$. Removal of a window of bone from the outer aspect of the mandible revealed a similar abscess at the root of the unerupted $\overline{/8}$ (*Fig.* 104). Following upon rupture of the subperiosteal

abscess on the lingual aspect of the mandible, the adjacent mylohyoid muscle had become involved, and from this focus a diffuse suppurative inflammation had spread rapidly through the soft tissues of the neck. At many points the intermuscular septa were gelatinous with œdema, and small pockets of thin yellow pus had formed

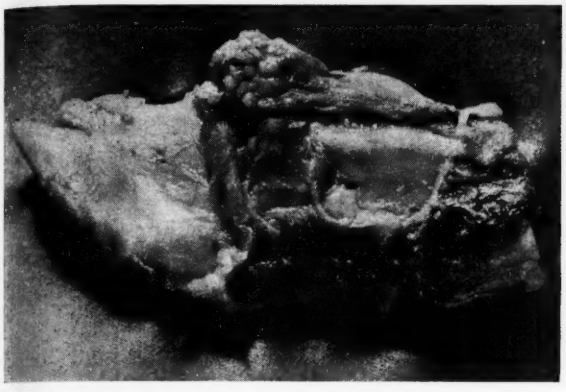


FIG. 103.—Left angle of mandible, inner aspect. A bare area of bone, denuded of periosteum, lies below /$\overline{7}$, the lingual aspect of which can just be seen. In the centre of this area is a small sinus communicating with a cavity at the roots of /$\overline{7}$.

(1) deep to the sternothyroid and sternohyoid muscles, (2) surrounding the right lobe of the thyroid gland, (3) between the upper œsophagus and prevertebral muscles, (4) in the superior mediastinum and peribronchial tissues, and (5) in the posterior mediastinum, representing the lowest limit of infection. Bacteriological culture of these abscesses yielded a growth of anaerobic hæmolytic streptococci (penicillin sensitivity factor, 0·5), and coliforms.

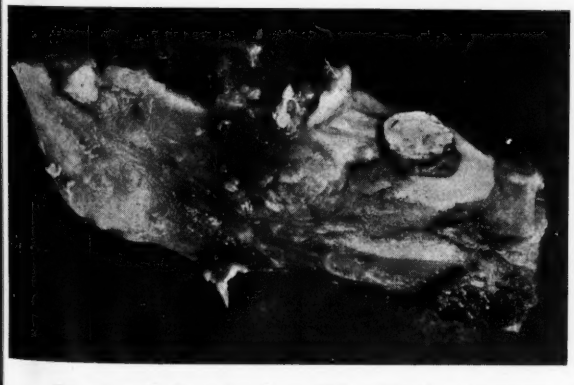


FIG. 105.—Left angle of mandible. Showing temporary dressing of zinc-oxide-eugenol-resin in /$\overline{7}$.

Removal of the dressing from /$\overline{7}$ (*Fig.* 105) revealed a surface which was smooth, blackened, and macroscopically sound. Careful probing, however, revealed a minute area of softened dentine, through which a sharp-pointed instrument passed into the pulp chamber.

Histology.—Sections of the mylohyoid muscle showed the necrotic muscle-fibres widely separated from one another by a highly cellular, acute inflammatory exudate (*Fig.* 106). There was obviously no attempt at tissue reaction to confine the spread of infection, which could be seen extending along the fibrous septa accompanied by a profuse serous exudate and small hæmorrhages.

The X-ray appearances of the angle of the mandible (post-mortem) are shown in *Fig.* 107.

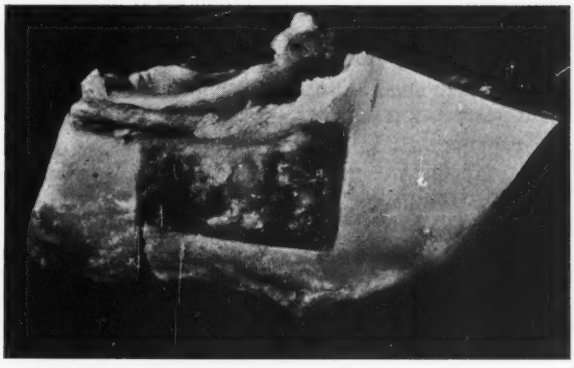


FIG. 104.—Left angle of mandible, outer aspect. A window of bone has been removed to expose abscess cavities at the roots of /$\overline{7}$ and the unerupted /$\overline{8}$.

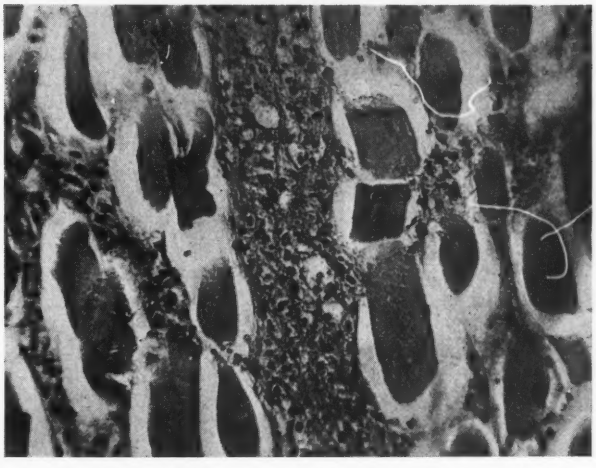


FIG. 106.—Mylohyoid muscle. Showing the unrestricted spread of an acute inflammatory exudate between the degenerate muscle-fibres and along the tissue planes. (× 225.)

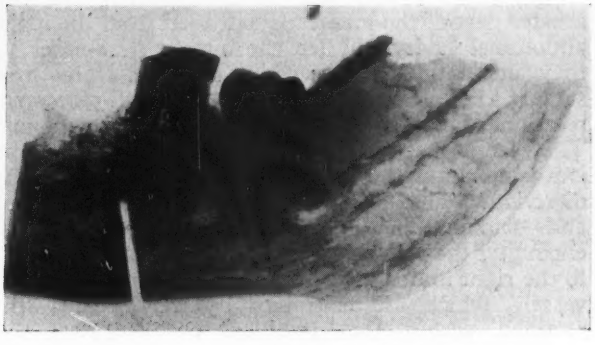


FIG. 107.—Radiograph showing cavities in the periapical bone in relation to both /$\overline{7}$ and /$\overline{8}$.

SUMMARY

1. A case of alveolar abscess in relation to /$\overline{7}$ progressing rapidly through the stages of cervical cellulitis to mediastinitis and death, is described.

2. A dressing had been inserted in /$\overline{7}$ some months previously, following which the tooth remained symptomless until three days prior to

admission. An unerupted left third molar was also present with areas of apical osteitis in relation to both $\overline{/7}$ and $\overline{/8}$.

3. Diffuse swelling of the neck occurred following upon perforation of the lingual plate of the mandible and rupture of a subperiosteal abscess in $\overline{/7}$ region. The predominant symptom in the later stages was extreme dysphagia, becoming complete some hours before death.

4. Parenteral penicillin was administered with apparently little effect. Culture of organisms from the mouth, and later from pus, produced a hæmolytic streptococcus of relatively low penicillin sensitivity.

5. Autopsy revealed a widespread, fulminating infection of the neck which had extended to the superior and posterior mediastinum, with little or no tissue reaction to limit the spread of infection. The aetiological factors of this lessened resistance are not known.

6. Removal of the dressing from $\overline{/7}$ revealed a macroscopically sound dentine surface. Examination with a probe disclosed a minute area of softened dentine, leading to the pulp chamber.

CONCLUSIONS

1. The danger of an acute alveolar abscess in the lower molar region perforating the lingual plate of the mandible is well known. When the perforation occurs superior to the attachment of the mylohyoid muscle, the condition known as Ludwig's angina is likely to ensue, with associated gross œdema of the floor of the mouth and possibly of the glottis. In this case the perforation occurred below the mylohyoid ridge, and rapidly became of a widespread nature with involvement of the mediastinum. The respiratory passages were involved only to a small extent.

2. Chemotherapy was not continued subsequent to admission owing to the extreme dysphagia and the fact that penicillin was immediately available. Later, when the penicillin sensitivity factor of the organism was found to be relatively low, intravenous chemotherapy might with advantage have been instituted.

3. Conditions predisposing to acute medullary infection of the mandible may remain unsuspected for considerable periods before passing into an acute and gravely dangerous stage.

Our thanks are due to Colonel G. H. Haines, M.C., O.C. 15 (Scottish) General Hospital, and to Colonel B. E. Gentleman, D.D.D.S., M.E.F. We are indebted to Major-General J. C. A. Dowse, C.B.E., M.C., D.M.S., M.E.F., for permission to publish this article. The accompanying photographs are the work of Pte. P. Wood, R.A.M.C.

DERANGEMENT OF MIDGUT ROTATION PRODUCING VOLVULUS

A REPORT OF TWO CASES

By C. E. P. MARKBY

Developmental errors in the disposition of the midgut are due to the complicated evolution through which the midgut has to traverse in order to obtain its normal position.

At the fourth week of intra-uterine life the greater part of the midgut is extruded from the main abdominal cavity. When the intestines re-enter it, they undergo three stages of rotation. The first stage is a simple one, and consists of an anti-clockwise rotation of the whole of the midgut through 90°. The second stage is the crucial phase. The midgut is rotated through a further 180° in an anti-clockwise direction. The first part to enter is the proximal end—namely, the duodenum and jejunum. They encounter the resistance of the liver, and are deflected to the right under the axis of the superior mesenteric vessels, which are held taut by the cæcum, still retained within the umbilical cord. Thus, the uppermost portion of the coil, the terminal part of the duodenum, comes to lie behind the vessels. The jejunum and ileum follow the same course. When the cæcum eventually returns to the abdominal cavity, the small intestines lie to the left, with the colon to the right. The third stage is the descent of the cæcum and proximal colon to the adult position.

Derangements of the first stage of rotation are very rare, and are only met with in extroversion of the cloacæ; whilst those of the third stage commonly occur with non-descent, or abnormally high fixation, of the cæcum.

Derangements of the second stage of rotation have been classified by Dott (1923) as:—

1. *Non-rotation.*—The gut, on re-entering the abdomen fails to rotate, the small intestine remaining on the right and the proximal colon on the left. The duodenum descends from its normal fixed part to the right of the mesenteric vessels, with the coils of the small intestine occupying the right side. The lower part of the ileum, passing across the midline, enters the cæcum on its right side. The ascending colon lies to the left of the midline.

2. *Inverse Rotation.*—Rotation takes place through 90° in a clockwise direction, the proximal colon re-entering the abdominal cavity first, lying in a tunnel deep to the mesenteric vessels.

3. *Mal-rotation.*—When the small intestine passes in front of the mesenteric vessels, the cæcum also passes in front, but further progress to the right is arrested by the misplaced small intestine, and the cæcum remaining in the subpyloric area.

The commonest pathological sequel of non-rotation is a volvulus. If the whole of the midgut remains free, suspended from a narrow duodeno-colic isthmus, it is very apt to undergo volvulus, the whole of the midgut twisting around the axis of the mesenteric vessels. It often occurs in the first few days of life, producing a volvulus neonatorum. The diagnosis can be made clinically, when a young infant commences to vomit bile-stained material repeatedly. Volvulus implicating the post-arterial

segment, producing a twist of the terminal ileum, cæcum, and ascending colon, occurs later in adult life.

CASE REPORTS

The following is a report of a case of volvulus implicating the pre-arterial segment, due to non-rotation :—

HISTORY.—P. T., female child, aged 7½ years. Birth weight, 6 lb. 12 oz. Normal delivery. Third child. Rest of family well. Breast fed for 8 months. The child began to vomit when three days old, and vomiting

FIG. 108.—*Before operation—first opaque meal.* Shows dilated stomach and duodenal cap, both with fluid levels above the barium, possibly distended 2nd and 3rd parts of duodenum, and fluid level just distal to duodeno-jejunal flexure.

occurred directly after most feeds. She was always constipated, and required frequent enemas. The vomiting continued until she was weaned ; in spite of this, she managed to gain weight steadily.

The vomiting returned when she was 16 months old, but the quantity was smaller. Bowels were open once a week.

When she was 3 years old she developed a tuberculous cervical abscess, which was incised and curetted, but failed to heal. She was sent to a convalescent home for 6 months, during which time she had periodic attacks of severe vomiting.

When she was 5 years old she was admitted to a local Cottage Hospital for acute obstruction. She had been suffering from excessive vomiting, and there had been no bowel action for 14 days. She responded to stomach washouts and enemata, and was discharged after 3 weeks. She then made satisfactory progress for a year, with no vomiting, and her bowels were open regularly with small doses of agerol.

When she was 6½ years old her vomiting attacks returned. At this time she was thought to be a case of tuberculous peritonitis, and was re-admitted to the children's convalescent home. Nothing abnormal was found.

She was admitted to the Royal Victoria and West Hants Hospital in January, 1941, on account of repeated attacks of vomiting. Her weight was 2 st. 5 lb. Her abdomen was distended and tympanitic, but there was no dullness in the flanks or evidence of free fluid. Mantoux test was positive. She gained 3 lb. in weight and was discharged after a month.

She was re-admitted in March with loss of weight and continued attacks of vomiting.

ON ADMISSION.—Her general condition was poor, and she appeared to be very dehydrated. Her weight prior to operation was 1 st. 10 lb. She had no pyrexia, but was vomiting nearly every day about 30 oz. of clear greenish bile-stained fluid. *Radiological examination* was undertaken by Dr. Buckley, whose report was as follows :—

" X-ray before operation : A screen examination in the upright positions showed three fluid levels before any barium was swallowed. These were found to be

FIG. 109.—*First meal—24 hr. p.c.* Shows displaced cæcum along ascending colon, lying below and parallel to the transverse colon. The terminal ileum can be seen on the mesial aspect of the cæcum.

in the dilated stomach and the duodenal cap, and in the region of the duodeno-jejunal flexure. After the barium had been swallowed, the second and third parts of the duodenum suggested that the third fluid level was just distal to the duodeno-jejunal flexure. In the absence of tenderness, it was thought that the duodenal ileus must be caused by pressure from an abnormally situated superior mesenteric artery. There was still a trace of barium in stomach and duodenal caps at 48 hr. p.c. A film taken 24 hr. p.c. at first gave the impression that the colon was completely transposed, especially as the flexure in the left was lower than that on the right. Subsequent events, however, proved that the coil thought to be the descending colon was, in fact, the elongated ascending colon lying below and parallel to the transverse colon." (*Figs.* 108, 109).

AT OPERATION.—A laparotomy was undertaken. Anæsthetic given by Dr. Montgomery consisted of ethyl chloride and open ether. The stomach and first and second parts of the duodenum were moderately dilated, but were normally situated and attacked. The third part of the duodenum was more distended, but was normally placed in the retroperitoneal tissues, behind the mesenteric vessels. The site of the obstruction was at the beginning of the jejunum, which turned sharply to the right under the mesenteric vessels. It then spiralled round the mesenteric vessels in a clockwise direction for three complete turns. There was no obstruction to the vessels, and no engorgement of the loops. The volvulus was easily reduced by rotating

the whole mass of small intestine on its axis in an anti-clockwise direction.

When the twist was undone, it was found that jejunum, distal to the twist, was piercing the mesentery of a lower loop of the jejunum. From this point the small intestine ran in a normal manner, occupying the right side of the abdomen. The terminal ileum then crossed the mid-line and entered the cæcum at its normal situation. The base of the mesentery was shorter than normal, starting at the usual situation to the left of the second lumbar vertebra at the duodeno-jejunal fold, and running downwards to the right for only 1½ in. The mesentery was

FIG. 110.—*After operation—second meal.* Stomach now of normal size, but still containing a little residual fluid. Duodenal cap contracted and deformed in shape.

foreshortened. The cæcum was lying in the left hypochondrium, below the terminal portion of the transverse colon, and was anchored to the splenic flexure by peritoneal bands. The ascending colon appeared to have a mesentery which had become adherent to the transverse mesocolon. It was running transversely across the abdomen, just below the transverse colon, to the hepatic flexure, which was situated in its normal position, below the liver, in the right hypochondrium. The transverse colon, splenic flexure, and descending colon were occupying normal positions. The sigmoid colon seemed to be slightly longer than usual, and was more centrally placed. The rectum was normal. A duodeno-jejunostomy was performed, a side-to-side anastomosis being made between the distended third part of the duodenum and a portion of the jejunum distal to the point where it pierced the mesentery. The cæcum was then mobilized by dividing the bands, which held it to the splenic flexure. The cæcum and ascending colon were separated from the transverse mesocolon and swung over to the right. A cæcopexy was performed. The posterior parietal peritoneum was incised and mobilized, and the cæcum and ascending colon were then tucked into the pocket and anchored by means of interrupted stitches passing through the anterior longitudinal band of the cæcum to the cut edge of the parietal peritoneum.

PROGRESS.—The child has made an uneventful convalescence, and has had no recurrence of attacks. Now, four years later, she is a well-developed girl with a normal weight.

Radiological examination after operation: "A screen examination showed stomach and duodenal cap reduced to normal size, but the former still contained some residual fluid. The duodenal cap was deformed in shape but no barium would pass beyond this point until the child had been placed on the right side on the X-ray table. After this it made rapid progress, and the whole alimentary canal was free of barium at 24 hr. p.c. A film taken 8 hr. p.c. shows the new position of cæcum and ascending colon, with traces of barium in stomach and duodenal caps." (*Figs.* 110, 111.)

Comment.—The diagnosis of this case was made by radiological examination, and the lesion was located to the terminal portion of the duodenum,

FIG. 111.—*Second meal—8 hr. p.c.* Cæcum and ascending colon restored to normal position. Traces of barium in stomach and duodenal cap.

when it was thought to be compressed by the mesenteric vessels as in the case of duodenal ileus. The obstruction, however, was due to a volvulus of the upper end of the jejunum, around the mesenteric vessels. The age of the patient, and the exact localization of the obstruction, ruled out pyloric stenosis, congenital atresia of the intestine, and obstruction from a persistent Meckel's diverticulum. A mesenteric cyst or loop of bowel caught in a patent duodenal fossa might have been the cause. Volvulus neonatorum caused by a twist of the jejunum around the mesenteric vessels usually manifests itself within a few days of life, and is invariably fatal. It is interesting to note that the signs of obstruction did manifest themselves shortly after birth, as it is difficult to see how the whole of the small intestine could have possibly rotated itself through three complete circles but was not sufficient to occlude the bowel or produce strangulation. The extremely rare condition of the small intestine piercing its own mesentery, should be noted.

The following case illustrates a volvulus implicating the post-arterial segment due to an inverse rotation :—

HISTORY.—G. S., a woman aged 49 years, was admitted with intestinal obstruction. She had had colicky pains over the lower part of the abdomen for eight days. She had commenced to vomit three days prior to admission; the vomits were bilious at first, and

then were tending to become fæcal. She had had absolute constipation for five days. She had experienced a previous attack six months ago, but it had passed off. An enema, given before admission, produced no result.

FIG. 112.—The condition found post mortem.

ON ADMISSION.—She was a well-covered woman with an obvious abdominal distension. No mass could be felt, but there was some shifting dullness detected in the flanks. Audible peristalsis could be heard over the abdomen. On rectal examination nothing could be felt, but there was some peritoneal tenderness over to the right, and an indeterminate mass was thought to be present on bimanual examination.

AT OPERATION.—A laparotomy was performed under a spinal anæsthetic. The abdomen was opened through a left paramedian incision, and was found to contain some free fluid. The cæcum was very distended and congested, and had undergone a twist through 180° round the ascending colon. When the volvulus was unwound it was seen that, at the neck of the volvulus, the ascending colon disappeared into a retroperitoneal tunnel. It then ran upwards and to the left behind the root of the mesentery and the mesenteric vessels, to emerge at the normal splenic flexure. In order to fix the cæcum, a cæcostomy was performed, and a self-retaining catheter was inserted into the cæcum and brought out through a stab incision in the right iliac fossa. On return from the theatre, the patient's condition was very poor, and she died some thirty-six hours after the operation.

Post-mortem examination showed that she had died of a pulmonary embolus. The abnormal arrangement of the bowel was confirmed and is shown in the accompanying drawings (*Figs.* 112, 113).

My thanks are due to Dr. Buckley for her extremely helpful radiological examination and report, and also to Dr. Morse and Mr. Chilver Stainer for their drawings.

REFERENCE

DOTT, N. M. (1923), *Brit. J. Surg.*, **11**, 251.

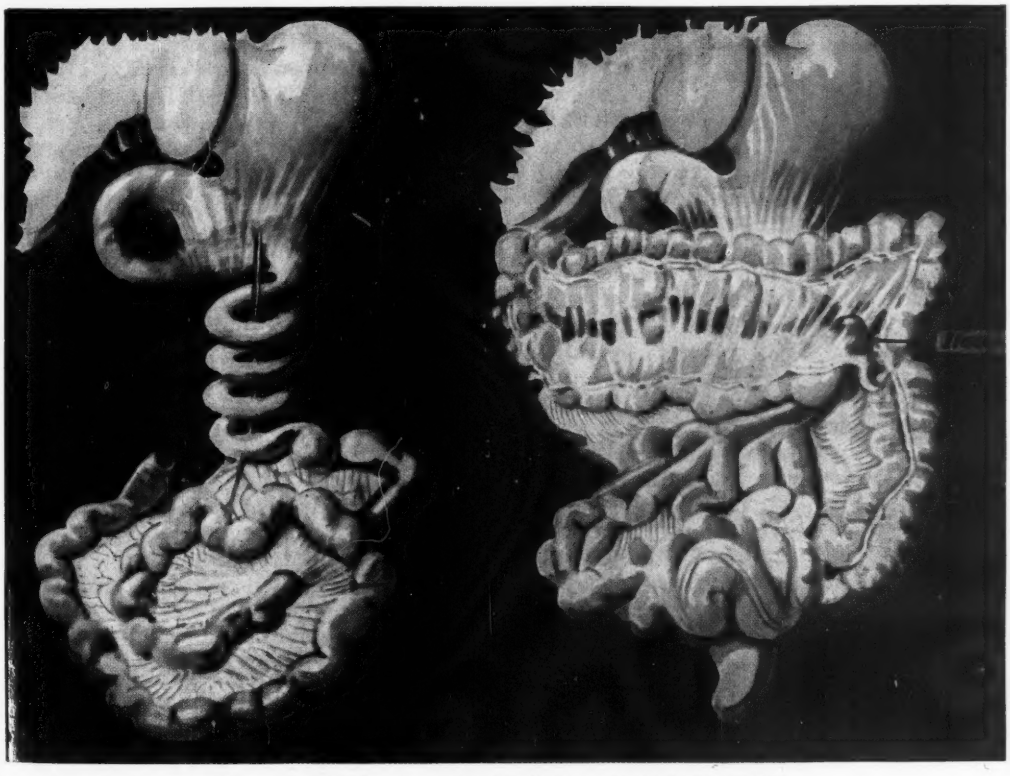


FIG. 113.—Showing in greater detail the anatomical abnormality.

RESECTION OF THE HEAD OF THE PANCREAS

By CHARLES A. PANNETT

PROFESSOR OF SURGERY, UNIVERSITY OF LONDON; SURGEON, ST. MARY'S HOSPITAL

CARCINOMA of the head of the pancreas frequently arises near the opening of the common duct, when obstruction to this structure gives early notice of its presence; or it may grow more distantly in the head and exist for some time before it spreads and hinders the outflow of bile. An example of the successful removal of each of these types of growth is reported here. They were removed in the simplest fashion, in one case without premeditation, by the use of ordinary, simple, long-established surgical methods.

In the first, a large piece of the pancreatic head, up to the level of the superior mesenteric artery, with all the duodenum except the end of the third part, was removed. The second resection was carried out in a woman also very deeply jaundiced. In her case, the whole of the head of the pancreas was taken away.

Several problems come to the fore when growths of the pancreas are removed, and they are not yet settled. One is whether the operation should be carried out in two stages, as advocated by Whipple (1935); that is, a primary cholecyst-gastrectomy with section and ligation of the common duct, combined with a gastrojejunostomy, followed later by removal of the growth; or whether the whole procedure be done in one stage. Hunt (1941) has operated in two stages successfully, and so has Child (1944), though he has been equally successful with a one-stage operation; and Whipple (1945) has recently declared himself in favour of doing everything at one time. On the other hand, Watson (1944) is a strenuous advocate of two stages. The chief argument in favour of two stages is the relief of the patient from the toxæmia of biliary obstruction at the primary operation, so that when the major procedure is done he will be the more able to withstand it. But both my patients went through a one-stage operation although there was intense jaundice which had been present for three months. In neither was there any abnormal tendency to bleeding. Vitamin K had been administered to one of them. An objection to two stages is the difficulty with adhesions at the second operation. It would seem better to do everything at one time unless the patient is extremely weak and feeble.

The next problem is what to do with the cut surface of the pancreas. If only a wide V is resected from the head it does not seem practical to implant the extensive raw surface into the jejunum; but if the whole head be removed the cross-section of the neck is not too large to do this. Physiologically it would seem much better that some pancreatic juice should enter the intestine.

Experimentally in animals fatty degeneration of the liver is said to take place after ligation of the pancreatic duct or total pancreatectomy. However, in man this does not appear to be the case, and ligation of the pancreatic duct with sewing over of the raw surface is allowable. In my patient nine months later there is apparently normal digestion. He eats what he likes, has no distaste for food, and has raised his weight from 7 st. 11 lb. to 11 st. Three weeks after the operation, indeed, the soaps and fatty acids in the stool amounted to 87·3 per cent of the total fats. At that time there were a few undigested muscle-fibres and starch granules to be found. The outcome, however, is not always so happy, as reports of deficient fat digestion have been made in some patients. Thus, Whipple (1945), in his case which had no jaundice, found a 30 to 50 per cent fat loss in the stools. Technically, the implantation of the pancreas into the bowel is not attractive. The capsule of the pancreas is thin, it does not take stitches well, and the passage of the needle may allow pancreatic juice to escape from the needle holes, which, activated by kinase leads to digestion of the fibrin upon which depends the water-tight joint. In my patient, in whom I implanted the pancreas, a watery discharge occurred on the fourth day which I took to be pancreatic juice. Unfortunately it soon became a purulent exudation and led to disrupture of the abdominal wall, necessitating re-suture ten days after her operation. The man whose pancreas had been sewn over also discharged pancreatic juice on the fourth day, which later became tinged with bile. But in ten days it had almost ceased and the wound was nicely healed. In any case it is essential to place a drainage tube down to the neighbourhood of the cut pancreas or the implantation. Also, it would seem better to use interrupted silk or cotton sutures in place of easily digested catgut.

The third problem is how to restore the flow of bile into the alimentary canal. It is very odd that surgeons should select an anastomosis between the gall-bladder and stomach or intestine with nothing but a simple ligature to close the common duct. When this ligature sloughs away bile must frequently escape from the end of the duct. Always the bile-duct should be implanted into the intestine. This is not difficult, as it is dilated.

The restoration of the alimentary canal should be made by an end-to-side anastomosis between the cut end of the stomach and the jejunum. I divide the stomach across just proximal to the pylorus and the duodenum to the right of the superior mesenteric artery, leaving just enough for in-turning. It does not seem necessary to go to the extent of dislocating the duodenojejunal flexure beneath the mesenteric vessels so that the first part of the jejunum may be cut across. Although the third part of the duodenum at this stage is denuded of peritoneum, closure in the ordinary way appears to be quite safe.

For the anastomosis in both my patients a long loop of upper jejunum was taken and thrown over to the right of the abdomen, so that forward peristalsis would run from right to left. The common bile-duct, the neck of the pancreas, and stomach were implanted in separate holes in this order also from

right to left in one; the bile-duct and the stomach in the other. The reason for this is that as there must be a considerable length between the duodeno-jejunal flexure and the place of entry of the gastric juice, it is advisable to have bile and pancreatic juice already in the bowel at this point in order to diminish the risk of a jejunal peptic ulcer.

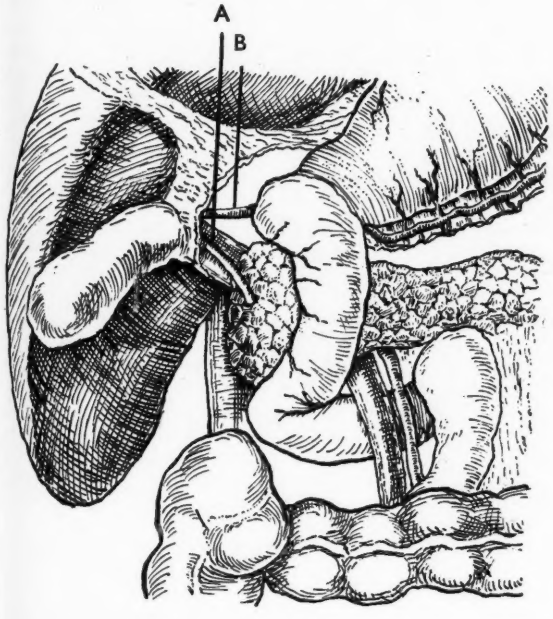


FIG. 114.—The hepatic flexure has been pushed downwards off the duodenum, the greater and lesser curvatures of the stomach near the pylorus freed, and the duodenum reflected to the left—exposing the vena cava inferior and the common bile-duct. A, Common bile-duct lying on portal vein; B, Hepatic artery.

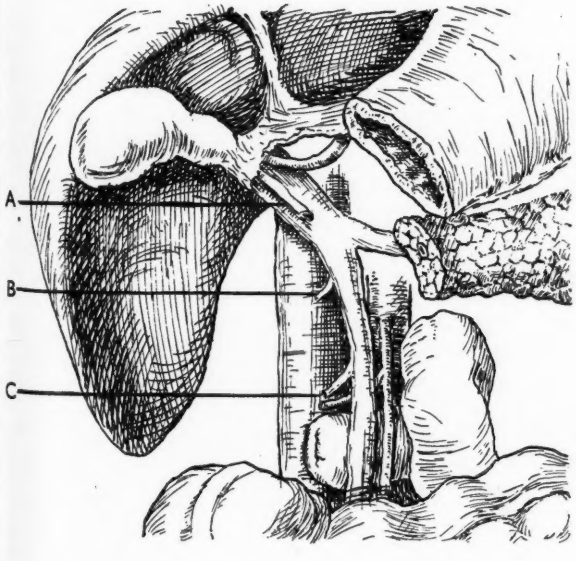


FIG. 116.—The pyloric fragment of stomach and the duodenum with the whole of the head of the pancreas have been removed. The pancreatic duct is seen in the section of the neck of the gland. Distal end of duodenum closed. A, Common bile-duct lying on portal vein; B, Superior pancreatico-duodenal vein; C, Inferior pancreatico-duodenal vessels.

OPERATION

The abdomen is opened by a paramedian incision. Having explored the condition of affairs and decided upon removal, the first step is to expose the third part of the duodenum by dissecting off the hepatic flexure of the colon and pushing the large bowel

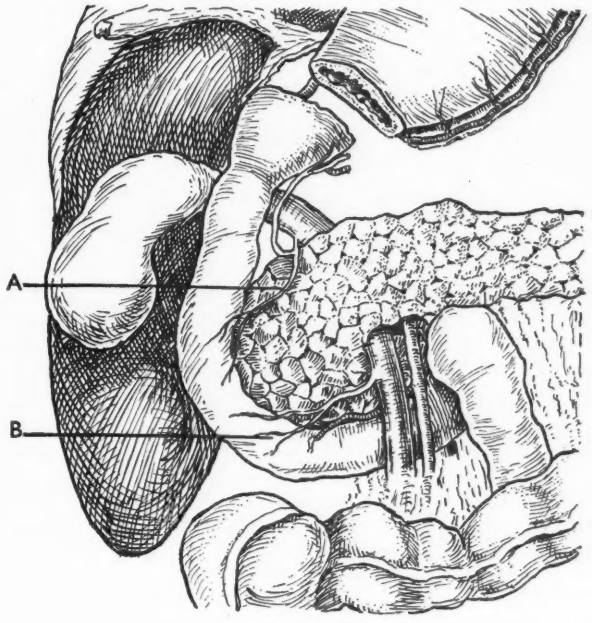


FIG 115.—The stomach has been cut across, the superior mesenteric vessels freed, and the portal vein dissected away from the pancreas. A, Superior pancreatico-duodenal vein; B, Inferior pancreatico-duodenal vessels.

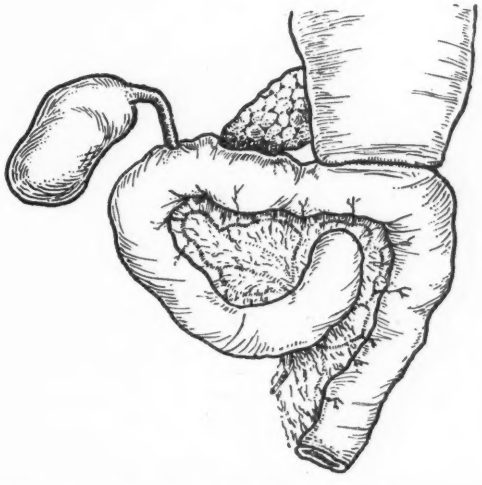


FIG. 117.—The common bile-duct, the neck of the pancreas, and the pyloric end of the stomach have been implanted severally into the first loop of the jejunum.

down. The lesser sac will have been opened in the primary exploration. Now about 1½ in. of the greater and lesser curvatures of the stomach are laid bare, and the stomach cut across between clamps just proximal to the pylorus (*Fig.* 115). The gall-bladder, tightly distended, is emptied by suction and the puncture oversewn. The peritoneum is incised to

the right of the second part of the duodenum and the cut carried upwards to meet the opening in the lesser omentum. The duodenum and head of the pancreas are easily lifted off the vena cava and turned over to the left, exposing the entrance of the common bile-duct into the pancreas (*Fig.* 114). The duct is divided and lightly clamped about ½ in. from its end. The next stage is more difficult. It is getting the uncinate process of the head from between the superior mesenteric vessels in front and the vena cava behind. The superior mesenteric vein must be traced for all its length until it becomes the portal vein. In the course of this dissection the neck of the pancreas is cut across, the gastroduodenal artery and its gastro-epiploic branch ligatured and divided, the superior pancreatico-duodenal vein severed as it joins the superior mesenteric or portal vein, and the inferior pancreatico-duodenal artery and vein dissected out, divided, and ligatured (*Fig.* 115). The duodenum is freed to the superior mesenteric vessels. It is clamped about ¾ in. from them, cut across, and closed by a doubly invaginating suture. I used a continuous catgut stitch for this, but for everything else, except the implantation of the stomach, cotton was employed. The duodenum and the whole of the head of the pancreas together with the growth are now freed and can be removed (*Fig.* 116). The first part of the jejunum is carried up in front of the transverse colon to the right of the abdomen and placed so that it runs transversely from right to left. The bile-duct is now implanted into a hole in the jejunum. Four cotton sutures suffice to join it to the opening, after which the anastomosis is invaginated by a few Lembert stitches. About 1 in. farther along a larger hole is made for the neck of the pancreas. This also is implanted with two rows of separate cotton stitches. Then a little farther on still the stomach is implanted in the ordinary way, a continuous catgut suture being used (*Fig.* 117).

If the whole head of the pancreas is not excised, but only a V-section made, the pancreatic duct is ligated and the raw surface closely oversewn. In either case a drainage tube must be left going down to the neighbourhood of the cut pancreas or its implantation.

The abdomen is closed.

The after-treatment does not differ from that of any serious abdominal operation. Removal of the whole head took two hours and fifty minutes. This patient received 2 pints of blood afterwards. But the other patient was so well that a blood transfusion was not necessary. His convalescence was without any incident except for the pancreatic fistula already mentioned. He was up, with his wound healed, on the nineteenth day.

The woman who lost the whole of the head of the pancreas did not fare so well. The wound became septic and had to be re-sutured on the tenth day. Gram-positive cocci, diplococci, and colon bacilli were in the pus and penicillin did not control the infection. For two months this suppuration went on, necessitating the opening of two small abscesses in the lower part of the abdominal wall. But all this time the general condition was good, the jaundice disappeared, and the appetite returned. Not until two months and three days had elapsed did the patient leave the hospital healed and well.

CASE REPORTS

Case 1.—H. L., male aged 50, a carpenter, a patient of Professor Pickering, had had jaundice, itching, loss of appetite, and general malaise, with light motions and dark urine for three months.

ON EXAMINATION (July 26, 1945).—His liver was much enlarged and the gall-bladder felt distended. There was intense jaundice. The serum-bilirubin was 5 mg. per 100 c.c. A diagnosis of carcinoma of the pancreatic head was made.

OPERATION (July 30).—A resection up to the level of the superior mesenteric vessels was carried out as described above.

Microscopical Report: Papillary tubular columnar-cell, sometimes trabecular polygonal-cell, carcinoma invading head of pancreas and intestinal mucosa at ampulla of Vater.

Pulse rose from 68 at the beginning to 82 at the end of the operation. It only rose to 84 the next day. He absorbed 4 pints of rectal water the night of the operation and 4 pints the next day.

Aug. 4: Clear fluid began to escape from the drainage tube and became a profuse flow. It was pancreatic juice and caused some reddening of the surrounding skin. Zinc cream was used to protect the skin. Powdered aluminium could not be obtained. The wound remained soundly healing. The discharge became tinged with bile.

Aug. 14: Discharge from tube scanty. Jaundice gone. Stools normal. Eats almost anything.

Aug. 19: Wound healed. Patient out of bed.

Aug. 20: Stool examination: A moderate number of partly digested muscle-fibres and a few starch granules. Also a few fat globules and an occasional pus cell. Soaps 60·9 per cent total fatty bodies, fatty acids 26·4 per cent, neutral fats 12·7 per cent.

April 15, 1946: Patient extremely well. Eats anything. Working as carpenter. His weight has gone up from 7 st. 1 lb. to 11 st.

Case 2.—K. S., female aged 50, a patient of Professor Pickering. Three months ago began to suffer from headache, lassitude, vomiting, and jaundice. She suffered from itching, the stools were pale and the urine dark.

ON EXAMINATION (Nov. 26, 1945).—A very thin woman, deeply jaundiced, with very much enlarged liver and a palpable gall-bladder. Skin had many scratch marks. Stools pale. Urine contains bile.

Blood-proteins 5 per cent, albumin 2·8 per cent, globulin 2·2 per cent. V.-d.-B. reaction: immediately red, violet in three minutes. Bilirubin 12 mg. per 100 c.c. Serum-cholesterol 527 mg. per 100 c.c.

Vitamin K (10 mg.) with bile-salts (325 mg.) was given twice a day for five days. Also glucose by mouth.

OPERATION (Dec. 10).—The whole pancreatic head was removed as described above.

Microscopical Report: Alveolar, tubular, and trabecular cubical- and polygonal-cell carcinoma of the pancreas invading duodenum and lymph-gland. Mitotic figures scarce.

Rectal water given and 2 pints of blood transfused after the operation.

Dec. 14: A profuse watery pancreatic discharge has begun.

Dec. 16: The discharge has now become purulent. The patient has vomited several times. Ryle's tube passed, and glucose given intravenously.

Dec. 17: Ryle's tube again passed and left down for 30 hours. Discharge purulent and copious.

Dec. 20: General condition good since Ryle tube removed, but wound margins separating. Wound resutured. To have systemic penicillin for five days.

Dec. 22: Less discharge, though still a fair amount. No vomiting. Slight distension. Jaundice much less.

During all January, 1946, pus continued to issue from the wound. It contained cocci in small numbers, diplococci, and colon bacilli which did not seem sensitive to penicillin. Also many *B. proteus* were present. The general condition of the patient was steadily improving, however.

On Jan. 6 and Jan. 11, 1946, pockets of pus were drained in the lower part of the wound. The upper part which led down to the site of the excision was at this time healed. The jaundice had disappeared and the appetite was good. It was not until Feb. 15 that the discharge of pus finally ceased, and the patient was discharged 67 days after her operation.

REFERENCES

BERG, B. N., and ZUCKER, T. F. (1931), *Proc. Soc. exper. Biol., N.Y.*, **29**, 68.
CHILD, C. G. (1944), *Ann. Surg.*, **119**, 845.
HUNT, W. C. (1941), *Ibid.*, **114**, 570.
WATSON, K. (1944), *Brit. J. Surg.*, **21**, 368.
WHIPPLE, A. O. (1945), *Ann. Surg.*, **121**, 847.
— — PARSONS, W. B., and MULLINS, C. R. (1935), *Ibid.*, **102**, 73.

BRODIE'S DISEASE OF THE BREAST

By DAVID AIKEN

RESIDENT SURGICAL OFFICER, CHRISTIE HOSPITAL AND HOLT RADIUM INSTITUTE, MANCHESTER

In 1846, Sir Benjamin Brodie published his "Lectures Illustrative of Various Subjects in Pathology and Surgery." In one of the lectures he gave a description of the condition which is recognized to-day as Brodie's disease of the breast. It is just a hundred years since the classical account appeared, and it is opportune, therefore, to consider the present conception of this tumour, which is often confused with carcinoma and sarcoma, although it belongs to the fibro-adenoma group and is essentially benign.

HISTORICAL NOTE

Unusually large non-cancerous breast tumours were recognized early in the nineteenth century, and the first account in British literature appeared in 1827, when Dr. Cumin, of Glasgow, recorded a typical case. The breast tumour was as large as a child's head and weighed 57½ oz. It was successfully removed, and ten years later there was no sign of recurrence. In 1829, Sir Astley Cooper drew attention to similar breast neoplasms and described them as the "second species of hydatid disease." His description is worthy of quotation :—

> the patient, "aetat 58, had an enormous enlargement of her left breast, which she first discovered 18 years ago, and then supposed it arose from a blow. When she first observed it, its size was that of a marble ; it felt hard, and was unattended with pain.
>
> "It appeared to be buried in the substance of the breast, and was not very movable in the glandular structure. It increased gradually until two years ago, by which time it had acquired the size of a melon. At that period it seemed to increase suddenly, and to grow faster than before, but it was still unattended with pain, and her general health did not appear to suffer.
>
> "On the 30th September, 1822, I first saw her, and the tumour then measured thirty-five inches in circumference ; in the greater part it was solid, but in other parts it was soft and fluctuating, and one bag evidently contained a large quantity of fluid. . . . Her general health was good, but she suffered much from its weight drawing down the skin and pectoral muscle, and putting the nerves exceedingly upon the stretch."

The tumour which he removed is illustrated by an excellent coloured plate in his book.

In 1838, Johannes Muller, in Germany, gave an account of several cases of this disease, calling it cystosarcoma phyllodes because of its leaf-like appearance. He distinguished this growth from other breast lesions and stressed its non-malignant nature.

The next clear description of the clinical and pathological features of the condition was that of Sir Benjamin Brodie (in 1846). He, and his contemporary, Cooper, regarded the neoplasm as an advanced stage of cystic disease of the breast ; but Brodie's penetrating observations and gift of graphic description earned him the deserved honour of the eponym. In his classical account, he states :—

> "the disease had probably been of long duration ; . . . the breast had attained an enormous size, being not less than seven pounds in weight. She was a middle-aged person, otherwise in good health, and the skin and axillary glands were free from disease . . . the diseased breast was amputated. The wound healed favourably ; and I heard of the patient being alive and well several years afterwards."

Since Brodie's day, numerous and confusing names have been applied to this type of tumour—for example, cystosarcoma, fibrolipoadenoma intracanaliculare sarcomatodes xanthomatodes mammæ, etc. (Owens and Adams, 1941), but the majority of these should be discarded because they classify it as a sarcoma. Brodie stressed its non-malignancy when he observed "the disease seems to be entirely local. It belongs to the breast and nothing else. It does not contaminate either the skin or lymphatic glands. . . ."

It appears to have been a rare tumour in his day and it is so still. Only 125 cases have been recorded to date in the medical literature (Lee and Pack, 1931 ; Owens and Adams, 1941 ; Cooper and Ackerman, 1943), but it may be more frequent than is generally believed. Dr. H. Russell, Pathologist of the Christie Hospital and Holt Radium Institute, informs me that she has reported it four times among the last four hundred and forty specimens of tumours of the breast (of all kinds) which have passed through her hands, but in only two of the four was the whole tumour received for study.

CASE REPORT

HISTORY.—On Feb. 12, 1945, Mrs. B., a mill worker aged 68, consulted her doctor on account of a lump in the right breast (*Fig.* 118). On seeing the breast he immediately referred her to the Clinic, where she came under the care of Mr. Wilson Hey.

FIG. 118.—Clinical photograph of patient on admission.

Past History.—The patient had always been healthy. She had had five pregnancies which were normal and the children were nursed from both breasts without difficulty. During her first pregnancy, when 28 years old, the doctor in charge discovered a small lump in the upper outer quadrant of the right breast. This was no larger than a cherry and symptomless and she decided against removal. At each succeeding pregnancy it became a little larger but almost "settled down" again in the intervals.

Present History.—In 1940 the lump began to enlarge and thereafter steadily increased in size and weight. In 1944, following an injury, the tumour grew more quickly and the weight of the breast increased to such an extent that a sling was required to support it. She had no pain apart from a "dragging" sensation due to the weight. There was no nipple discharge.

PHYSICAL EXAMINATION.—The patient was a well-nourished healthy woman; the heart, lungs, and central nervous system were normal; the breasts were pendulous, the right being lower than the left. The entire right breast was replaced by a bulky lobulated mass.

The skin overlying it was dusky in appearance, especially at the outer side, and the cutaneous veins were prominent. The nipple was normal. On palpation the tumour was found to be heavy, painless, and freely movable on the chest wall. The lobulations were produced by fluctuating superficial cysts. At the outer side the tumour was almost on the point of bursting through the skin. The consistency was firm apart from the cystic areas. There were no palpable axillary or supraclavicular lymph-nodes.

TREATMENT.—On Feb. 26, 1945, under pentothal and gas–oxygen anæsthesia, a right simple mastectomy was performed by the writer, using a transverse elliptical incision. The tumour was exceedingly vascular. Removal of the pectoral fascia was unnecessary. One year later there was no evidence of recurrence.

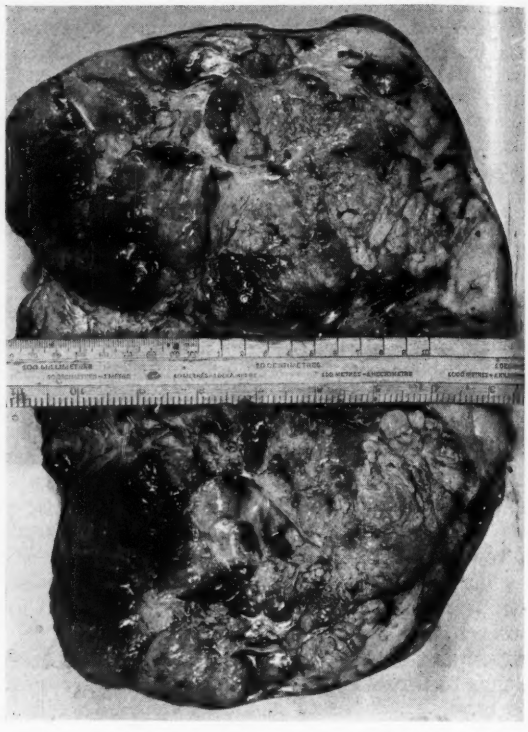


FIG. 119.—Photograph of gross specimen divided in half.

THE SPECIMEN.—The tumour weighed 2,370 g. and measured 20 × 12·5 cm. It was lobulated and the cut surface revealed hard, white, pearly, whorled areas alternating with soft, degenerating, myxoma-like lobules, some of which had become cystic. Near the periphery were two or three hæmorrhagic areas. In the centre of the tumour was a large dilated duct. (*Figs.* 119, 120.)

FIG. 120.—Drawing of tumour.

Histological Examination.—The white whorled areas showed the appearance of a cellular intracanalicular fibro-adenoma (*Fig.* 121) and these merged into the myxoma-like lobules. The latter (*Fig.* 122) were full of fibroblast-like cells extremely uniform in size and shape, some of them dividing. The mitotic figures were quite regular (*Fig.* 123).

FIG. 121.—Low-power magnification, showing the intracanalicular fibro-adenoma pattern.

DISCUSSION

The term ' Brodie's tumour ' should be reserved for large excessively cellular and long-neglected fibro-adenomata. The history of a pre-existing breast tumour of many years' duration which at first grows slowly or not at all, and finally in late middle age increases rapidly in size, is the outstanding feature of a Brodie's tumour. Commencing as a fibro-adenoma, it maintains the characteristics of an innocent lesion throughout. The skin overlying the tumour is mobile, there is no fixation to the deep structures, and the lymph-nodes are not usually involved, apart from hyperplasia due to inflammatory changes. Enlargement may be so great that ulceration of the skin occurs from pressure necrosis, and the foul, fungating mass in a patient past middle life at once suggests a carcinoma.* Sometimes the correct diagnosis of an innocent large tumour is impossible until the breast is removed. One striking clinical feature in typical cases is the excellent general condition of the patient.

Local recurrence following excision of the tumour has been reported on rare occasions, especially by the earlier writers, and convincing evidence of malignancy is even rarer. In the 125 cases referred to above, 4 were reported as sarcomas developing in a Brodie's tumour, but detailed study of the papers does not convince one that they were cellular tumours of the fibro-adenoma group which had become malignant.

The cut surface of a Brodie's tumour reveals an encapsulated mass showing white whorled areas, deep clefts, and translucent lobules, some of which degenerate into cysts. Microscopically its structure is that of an intracanalicular fibro-adenoma which has become very cellular and shows degeneration and even cystic softening. In the cellular areas of

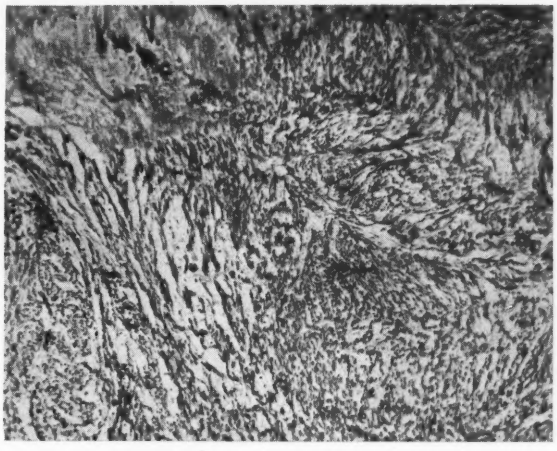


FIG. 122.—Showing myxoma-like areas.

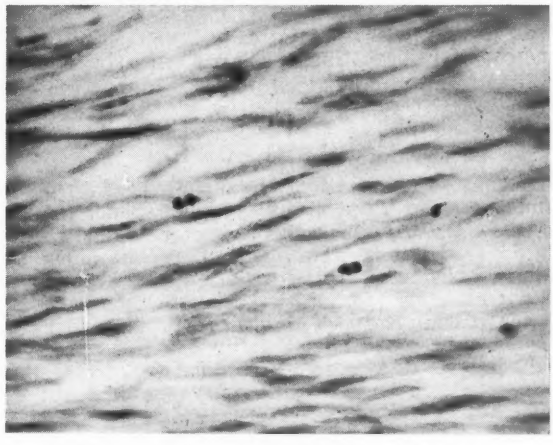


FIG. 123.—High-power magnification, showing the mitoses.

fibroblasts dividing cells may be found, but the mitoses are regular. It is this appearance which may lead to the diagnosis of sarcoma.

The best treatment of Brodie's tumour appears to be simple mastectomy, rather than local excision, for care must be taken not to leave any breast tissue behind in the skin-flaps. It is possible that recurrence of the tumour may take place from a fragment remaining in situ as in simple tumours of the parotid gland. It has been suggested that the rapid growth of these fibro-adenomata in late middle life may be associated with diminished œstrogen activity.

SUMMARY

A case of Brodie's tumour of the breast is reported.

It is recognized as a very large and long-neglected form of fibro-adenoma which is difficult to differentiate clinically from sarcoma (and sometimes carcinoma) of the breast.

Its essentially innocent character is maintained.

* There was a verbal tradition in surgical circles after Brodie's day that this tumour could be distinguished from a fungating carcinoma because a probe could be passed deeply between the skin and the tumour, presumably around the fibrous capsule.

I have to thank Mr. Wilson H. Hey for permission to publish this case. I am indebted to Dr. E. R. A. Cooper for the photomicrographs, and to Dr. H. Russell for helping me with the pathology.

REFERENCES

BRODIE, SIR B. C. (1846), *Lectures in Pathology and Surgery*, 147. London: Longmans Green & Co.

COOPER, SIR A. (1829), *Illustrations of the Diseases of the Breast*, pt. I, 41–45. London: Longmans Green & Co.

COOPER, W. G., and ACKERMAN, L. V. (1943), *Surg. Gynec. Obstet.*, **77**, 279.

CUMIN, W. (1827), *Edin. med. J.*, **27**, 230.

LEE, B. J., and PACK, G. T. (1931), *Amer. J. Cancer*, **15**, 2583.

MULLER, J. (1838), *Ueber den feinern Bau und die Formen der Krankhaften Geschwulste*. Berlin: G. Reimer.

OWENS, F. M., and ADAMS, W. E. (1941), *Arch. Surg.*, **43**, 588.

SHORT NOTES OF RARE OR OBSCURE CASES

COMPLETE TORSION OF A FIBROID UTERUS WITH ITS ADNEXA

BY ALAN H. HUNT

TEMPORARY ASSISTANT SURGEON TO THE METROPOLITAN HOSPITAL, LONDON; SURGICAL REGISTRAR TO THE ROYAL CANCER HOSPITAL (FREE), LONDON

AND L. WOODHOUSE PRICE

DIRECTOR OF THE PATHOLOGICAL DEPARTMENT, THE ROYAL CANCER HOSPITAL (FREE), LONDON

TORSION of a large fibroid uterus, with both tubes and ovaries, would appear to be an exceptional occurrence worthy of record.

CASE REPORT

HISTORY.—An unmarried woman, aged 51, was admitted to The Royal Cancer Hospital under the care of Mr. R. C. B. Ledlie, with severe abdominal pain of two days' duration. The pain was continuous and cutting in character, situated centrally in the abdomen and not radiating. Vomiting had at first been copious and the patient had been constipated. Her menstrual periods had been becoming scanty. She had been losing weight in spite of a protuberant abdomen.

Some eleven months previously she had suffered similar but milder attacks of pain, which had lasted for ten days.

ON EXAMINATION.—The abdomen was distended with a large smooth tender mass which extended to within three inches of the xiphisternum. It inclined to the right side and caused a protuberance in the right loin (*Fig.* 124). Intestinal sounds were normal. Pelvic examination showed that the cervix had been drawn up and was connected with the mass.

AT OPERATION.—It was found that there was an exceptionally large fibroid uterus which had twisted through three half-turns (540°) in a clockwise direction, carrying with it both tubes and ovaries. The pelvic peritoneum and broad ligaments had stretched to allow of this degree of torsion and the whole mass was lifted out of the pelvis. The twisted pedicle consisted of the attenuated supracervical segment of the uterus wrapped round with both broad ligaments, round ligaments, and infundibulopelvic folds. The whole was intensely congested, particularly the tubes and ovaries, which were blown up and black.

Subtotal hysterectomy with bilateral salpingo-oophorectomy was done after untwisting the mass. Owing to the distortion of the pelvic floor the pedicle was dissected with considerable care to ensure that the ureters were not also looped up into the twist.

The patient made a straightforward recovery except for a urinary infection which responded to simple treatment.

(A radiograph and a tomograph of the chest revealed a uniform, well-delineated opacity, 4 cm. in diameter, in the hilum of the left lung. Further radiographs taken five weeks later have shown no change in this opacity. It was considered extremely unlikely, in view of the pathological findings, that this single large pulmonary mass was connected in any way with the uterine tumour.)

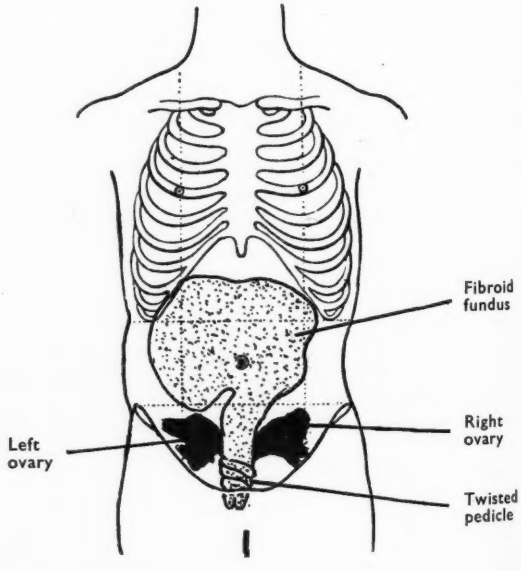


FIG. 124.—Drawing showing the abdominal distension.

THE SPECIMEN.—The specimen removed at operation is illustrated in *Fig.* 125. It weighed 9 lb. 10 oz., and measured 11 in. in its vertical and maximum transverse diameters and 8 in. antero-posteriorly. On hemisection the uterus was found to contain confluent fibroids (*Fig.* 126).

The histology of the uterine tumours was that of typical fibroleiomyomata. There was no evidence of any sarcomatous change or of any undue degenerative process. Conspicuous features were the intense congestion and engorgement of the intramural uterine vessels and the extensive degree of interstitial hæmorrhage.

Sections from the ovaries showed interstitial hæmorrhage, but no evidence of any ovarian tumour.

FIG. 125.—The specimen.

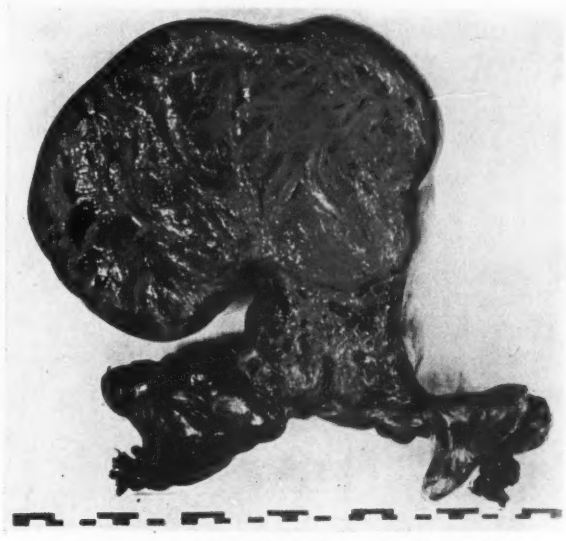


FIG. 126.—Section through specimen, showing confluent fibroids.

We wish to record our thanks to Mr. Ledlie for permission to publish this case. The patient was referred to The Royal Cancer Hospital by Dr. A. M. Ross.

ILEOCOLIC INTUSSUSCEPTION ASSOCIATED WITH NON-ROTATION OF THE MIDGUT, CONGENITAL HEART DISEASE, AND CONGENITAL HYDROCELE

BY D. P. VAN MEURS

COUNTY HOSPITAL, FARNBOROUGH

THIS case is put on record mainly to support the contention that lack of fixation of the ileocaecal region is an important factor in primary intussusception. The case provided an interesting diagnostic problem and also an example of the frequent multiplicity of congenital abnormalities.

CASE REPORT

HISTORY.—R. J., male, aged 5 years, was admitted to hospital on May 12, 1945, with a history of intermittent attacks of colicky abdominal pain and vomiting for eight days. During the first two days of the illness the attacks were fairly frequent but not severe, and the patient was constipated. There were a few slight attacks of colic during the next four days, and the bowels were kept open with liquid paraffin. The attacks then gradually became more severe and frequent until they were occurring about every fifteen minutes and lasting about two minutes. He was constipated again, and no blood or mucus had been passed per rectum. On the day before admission a swelling had appeared in his scrotum.

He had been cyanosed since birth, and congenital heart disease had been diagnosed two years previously at another hospital. At this time a transient swelling had been present in his scrotum.

ON EXAMINATION.—He was deeply cyanosed, with marked clubbing of the fingers, but apart from this his condition was good. The abdomen was slightly distended, and without tenderness or guarding. No mass could be felt except for the liver, which was enlarged to two fingers below the costal margin. The rectum was empty, and there was no blood or mucus on the examining finger. The scrotal swelling was a fairly tense right hydrocele, which could not be emptied. The apex-beat was just outside the left midclavicular line. There was a harsh systolic murmur maximal in the third left interspace and a very loud slapping pulmonary second sound. The blood-pressure was 90/60.

He was seen to have three attacks of colic whilst in hospital, and vomited during the third attack.

It was not difficult to make a diagnosis of intestinal obstruction and the possibility of the presence of some abnormality in the development of the midgut was mentioned.

OPERATION.—The patient was anæsthetized with cyclopropane and oxygen, using a closed-circuit machine. A right paramedian incision disclosed that the small intestine was moderately distended, but there was no excess of free fluid. The stomach seemed to occupy the midline and the great omentum hung freely from it. The cæcum was found under the left lobe of the liver,

and the rest of the large intestine occupied the left side of the peritoneal cavity. An intussusception had extended for about eight inches, nearly as far as the beginning of the sigmoid colon. This was easily reduced and was of the ileocolic type. The bowel was healthy except for the usual œdema of the apex, and no tumour could be felt. The ileocæcal glands were about half an inch each in diameter, and one was removed for section. No attempt was made to fix the mobile large bowel, and the appendix was not removed. The wound was closed in layers and the patient sent back to the ward in a good condition.

FIG. 127.—Barium meal showing position of stomach and jejunum.

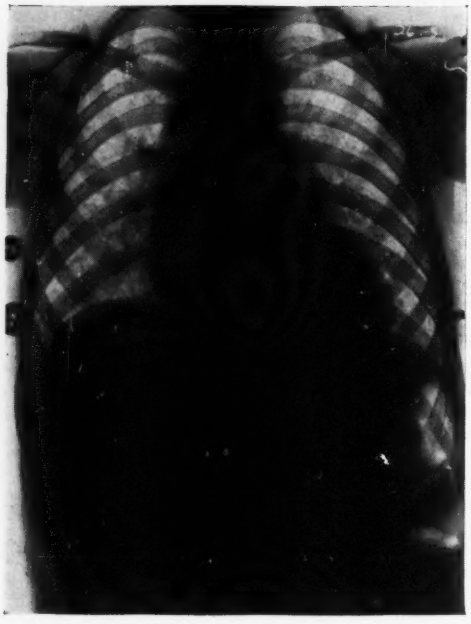


FIG. 129.—Heart showing enlargement, diminished prominence and concavity of the pulmonary artery, and projection to the right of the aorta.

Recovery was only delayed by a mild right parotitis, and the patient has remained well since. The hydrocele had disappeared by a week after operation.

INVESTIGATIONS.—Section of the gland removed showed no abnormality. Subsequent radiographs show the salient features of complete failure of rotation of the midgut with a reversal of the position of the stomach, and also the typical picture of the tetralogy of Fallot (*Figs.* 127–129). The hæmoglobin was 130 per cent and the red cells 8,130,000 per c.mm.

FIG. 128.—Barium meal at 4½ hours. The ileocæcal junction is shown to the left of the fourth lumbar vertebra.

DISCUSSION

The presence of multiple congenital abnormalities needs no comment. As far as can be ascertained there is no previous report of a primary intussusception occurring in a case of malposition of the midgut.

In infancy the ileocæcal angle is usually mobile, and it is obvious that, to allow an intussusception to advance far, this mobility must be very great or the mesentary of the terminal ileum must be extremely long. Stretching of the mesentery can play little part. The degree of lack of fixation of the ascending colon is not usually appreciated at operation as the bowel should not be withdrawn from the wound, except perhaps to inspect the intussusceptum, to confirm complete reduction, or possibly to deal with gangrenous bowel. But even after only partial reduction it is often evident that the whole intussusception could be lifted out of the wound, even though distended large bowel takes up its mesentery and tends to become less mobile.

A hypermobile ascending colon cannot, of course, be in any way the cause of an intussusception, but it is suggested that it is a factor which allows it to occur. The generally accepted theory that swelling of the lymphatic tissue in the terminal ileum and ileocæcal region acts in the same way as a tumour projecting into the lumen of the bowel (Perrin and Lindsay, 1921) agrees with the usual finding of

enlarged ileocæcal lymphatic glands such as were present in this case, and noted by Atkinson and Wakeley (1938). Whether the original cause of the lymphatic enlargement is infective or dietetic is so far undecided. The rarity of primary intussusception after the age of eighteen months suggests that some speccial factor acts in infancy and not in later life, when it is still fairly common to find a mobile cæcum and ascending colon.

A hypermobile ascending colon may be regarded as failure of completion of the third stage of rotation of the midgut, and a case can be made out for suggesting that primary intussusception may be a complication of this abnormality. In this particular patient a gross degree of mobility of the bowel allowed an intussusception to occur at an unusual age.

SUMMARY

1. A case is described in which a primary intussusception was associated with non-rotation of the midgut, congenital hydrocele, and congenital heart disease.

2. It is suggested that failure of fixation of the midgut in the third stage of rotation may be a factor in allowing an intussusception to occur.

REFERENCES

PERRIN, W. S., and LINDSAY, E. C. (1921), *Brit. J. Surg.*, **9**, 46.

ATKINSON, F. R. B., and WAKELEY, C. P. G. (1938), *Brit. J. Child. Dis.*, **35**, 241.

ACUTE MILIARY ACTINOMYCOSIS FOLLOWING PERFORATED GASTRIC ULCER

BY ANTHONY S. TILL

SURGICAL REGISTRAR, MIDDLESEX HOSPITAL

CASE REPORT

E. M., MALE, aged 26, a fishmonger, was admitted drunk to the Middlesex Hospital in the early hours of June 24, 1934, with a perforated gastric ulcer.

OPERATION.—General anæsthetic, perforation sutured, stab drain into the pelvis, incision closed. Uneventful convalescence.

Readmitted Oct. 1, complaining of abdominal pain and that his bowel had not acted for seven days. There was tenderness in the lower abdomen and the right iliac fossa. Rectal examination revealed a large firm mass in the pouch of Douglas, bulging into the rectum.

SECOND OPERATION.—The abdomen was reopened through a median subumbilical incision and dense masses of adhesions were found which involved small bowel, rectum, and bladder, and obliterated the pouch of Douglas. Such was the induration of the mass felt in the rectum on examination and also when the abdomen was opened, that it was thought that an abdominal swab had been left in at the time of the first operation. No such foreign body was forthcoming.

Self-closing cæcostomy was performed to relieve the intestinal obstruction.

The possibility of actinomycosis was also considered at this second operation, when it was clearly demonstrated that no foreign body was present. The patient was forthwith put on increasing doses of iodide of potassium and the mass in the pelvis gradually decreased in size under this treatment. Wassermann reaction and Cassoni test were both negative.

Two years later—Oct. 5, 1936—a mass appeared in the upper part of the abdomen, apparently in the neighbourhood of the liver.

OPERATION.—The abdomen was opened over the mass and an abscess in the substance of the liver was evacuated. The pus contained a small mycelium possessing the characters of the *Streptothrix actinomyces*. Potassium iodide was continued in doses of 70 gr. three times a day. Any attempt to increase the dosage was followed by symptoms of iodism.

The tentative diagnosis of actinomycosis at the second operation derived further support from the local amelioration of the pelvic condition under iodine therapy and was now fully confirmed by the discovery of the organism in the liver pus.

The mass in the hepatic area gradually disappeared, but the thickening in the pelvis was still palpable although of much smaller dimensions. There was no difficulty in bowel evacuation and the cæcostomy had long since closed.

Following the evacuation of the actinomycotic abscess of his liver, the patient was able to resume his employment, performing a full day's work. He remained well for fifteen months, when he suddenly developed a cough. A fortnight before his final admission to hospital he had a hæmoptysis, and a week later began to experience some abdominal pain and noticed that his belly swelled. His appetite disappeared and he lost weight rapidly in the last week or two before admission.

RE-ADMISSION (Feb. 16, 1938).—Pulse-rate ranged above 120. Temperature remained normal, but towards the end there was an evening rise. Râles were audible at the bases of both lungs.

Paracentesis of the abdomen led to the withdrawal of 4 pints of yellowish fluid and had to be repeated before death. The fluid contained a few epithelial cells, red blood-cells and an excess of polymorphonuclear white cells.

Sputum examination showed the presence of *Streptothrix actinomyces* in moderate amount. No tubercle bacilli were found.

Blood-count:—

Hæmoglobin 65 per cent. R.B.C. 3,900,000.

W.B.C. :—

Neutrophils, 86 per cent
Lymphocytes, 8 per cent
Monocytes, 6 per cent

X-ray Examination of Chest.—Diffuse mottling throughout both lungs, with thickening of the diaphragmatic pleura (*Fig.* 130). The root shadows were not increased in density, there was no pulmonary cavitation or calcification. Appearances were consistent with the diagnosis of mycotic disease of the lungs.

Despite the exhibition of potassium iodide and the intravenous injection of collosol iodine, the patient's condition rapidly deteriorated. Hæmatemesis reduced his strength further, the ankles became swollen, coma supervened, and he succumbed on March 2, 1938, a fortnight after his admission to hospital and about a month from the commencement of the symptoms which ushered in the hurricane finale to his malady.

POST-MORTEM EXAMINATION.—Abstract from Bland-Sutton Institute Report, 42/38.

The body was that of an emaciated man with a fistula in the cæcal region and a healed median laparotomy scar.

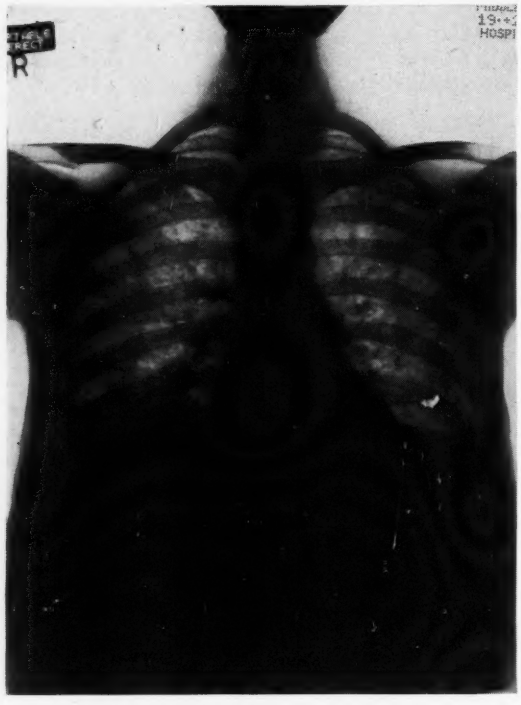


FIG. 130.—Radiograph of the chest, showing diffuse mottling throughout both lungs due to the miliary spread of the disease. On radiological grounds it may be impossible to distinguish this condition from miliary tuberculosis of the lungs.

A small quantity of fluid was found in each pleural cavity; there were adhesions over the diaphragmatic surface of each lung. The pleural surfaces of both lungs were studded with small, firm deposits resembling the miliary

FIG. 131.—Section through the lung showing the small pale miliary abscesses scattered throughout its substance.

spread of tuberculosis. On section of each lung, the whole cut surface was also dotted with multiple small firm nodules, which on pressure exuded yellow pus (*Fig.* 131).

FIG. 132.—Section through the right lobe of the liver, showing actinomycotic abscesses with characteristic loculated arrangement.

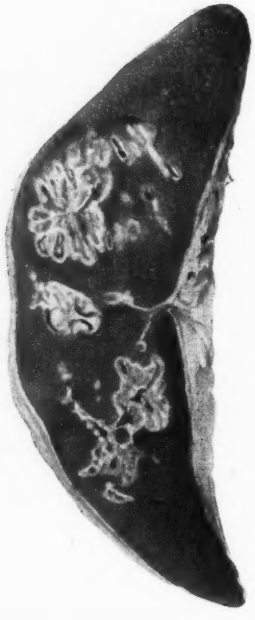


FIG. 133.—Section through the spleen showing actinomycotic abscesses.

The abdomen contained 5 pints of yellowish fluid; the coils of small intestine were quite free; there were four small yellow granular deposits in the wall of the jejunum a few feet from its commencement. The ileo-cæcal region exhibited no pathological change; there was no longer any evidence of actinomycosis in the sigmoid region, which was curved sharply on itself and fixed by adhesions. Although the transverse colon was free, there were dense adhesions implicating stomach, spleen, and splenic flexure on the left, and binding stomach, liver, and hepatic flexure on the right side of the abdomen.

The liver was honeycombed with abscesses and displayed the characteristic naked-eye appearance of actinomycosis (*Fig.* 132). The streptothrix was obtained from these lesions. The abscesses presented on the anterior surface of the right lobe and also on the superior surface, whence pus tracked upwards through the diaphragm. On the left side of the abdomen there were gross perisplenic adhesions encapsulating a small quantity of pus below the diaphragm.

The spleen (*Fig.* 133) and kidneys also showed miliary lesions, from which the organism was obtained.

The right suprarenal capsule showed a few small granular deposits in the cortex.

DISCUSSION

The generalized form of actinomycosis has been reported in the literature in a number of instances, but is still sufficiently rare to warrant the publication of another case. This patient was also remarkable in that the onset of the disease followed the perforation of a gastric ulcer, and that he survived the drainage of a hepatic abscess for fifteen months before the terminal hæmatogenous spread of the disease.

In 1925 Sanford and Voelker reviewed 670 cases of actinomycosis in the United States, and of these there were only 13 cases of the generalized disease. In the same year Werthemann (1925) collected 10 cases from the German literature and added two of his own. Further individual cases have been reported by Becker (1934) 2, Shapiro (1921) 1, Kasper and Pinner (1930) 1, Freed and Light (1932) 1, Fellinger and Salzer (1932) 1, Dixon (1939) 1, Parker (1923) 1, and others. Biggart (1934) has also described a case of the generalized disease due to the aerobic non-acid-fast strain classified by Topley and Wilson (1929) as *Actinomycosis graminis*, in distinction from the anaerobic *Actinomycosis bovis*, which is the generally accepted pathogen in man. Bates (1933) has collected post-mortem reports from the London Hospital of 6 cases of actinomycosis which succumbed as a result of hæmatogenous spread.

It is said that the pathogenic anaerobic organism may be resident in the mouth and around carious teeth, but, nevertheless, actinomycosis following perforation of an ulcer is exceedingly rare, though one might suppose that such a perforation would provide a ready portal of entry to the peritoneum. Possibly the high gastric acidity in these cases would destroy the streptothrix in most cases. Three cases only of this complication of perforation have been found in the literature; two by Cope (1938), of which the present case is one, and one by Bates (1933) in which an actinomycotic abscess developed in the left iliac fossa after perforation of a duodenal ulcer. This present case has been reported by Cope in his book on actinomycosis as a rare example of recovery after drainage of an actinomycotic abscess of the liver, but the subsequent history of the patient after this book was published confirms Cope's opinion that hepatic actinomycosis is almost invariably fatal.

A most uncommon exception has, however, been recorded by Chitty (1944) in which the patient was alive and well 15 years after operation on an actinomycotic mass in the liver which was as large as two fists and producing jaundice.

Death from actinomycosis may be due to destruction of vital structures with or without gross secondary infection, to hæmatogenous spread, or to amyloid disease. It seems probable, as pointed out by Bates and as shown by the eventual history of this case, that death from generalized actinomycosis is possibly not so rare as it appears, but that owing to the chronicity of the disease many patients may leave hospital before the fatal termination by miliary spread.

I wish to express my thanks to Surgeon Rear-Admiral G. Gordon Taylor for permission to publish this case, which was treated under his care in the Middlesex Hospital; and to Dr. H. Graham Hodgson for the radiograph of the patient's chest.

REFERENCES

BATES, R. (1933) *Lancet*, **1**, 571.
BECKER, H. (1934), *Dtsch. Z. Nervenheilk.*, **134**, 36.
BIGGART, J. H. (1934), *Bull. Johns. Hopk. Hosp.*, **54**, 165.
CHITTY, H. (1944), *Brit. med. J.*, **1**, 115.
COPE, V. Z. (1938), *Actinomycosis*. Oxford Univ. Press.
DIXON, G. J. (1939), *Brit. med. J.*, **2**, 686.
FELLINGER, K., and SALZER, G. (1932), *Virchow's Arch.*, **286**, 638.
FREED, C. F., and LIGHT, F. (1932), *Pennsylvania med. J.*, **36**, 25.
KASPER, J. A., and PINNER, M. (1930), *Arch. Path.*, **10**, 687.
PARKER, C. A. (1923), *J. Bone J. Surg.*, **5**, 759.
SANFORD, A. H., and VOELKER, M. (1925), *Arch. Surg.*, **11**, 809.
SHAPIRO, P. F. (1931), *Arch. Path.*, **12**, 397.
TOPLEY, W. W. C., and WILSON, G. S. (1929), *Principles of Immunity and Bacteriology*. London.
WERTHEMANN, A. (1925), *Virchow's Arch*, **255**, 719.

A CONGENITAL MELANOMA OF LIP WITH CYSTIC DEGENERATION

BY HOWARD REED
MEDICAL OFFICER, TANGANYIKA

CASE REPORT

AN African boy about ten years of age was brought to me in October, 1944, when I was stationed at Mwanza. His father told me that he was born with a large swelling of the upper lip which grew slowly until about one year ago, when it began to increase in size more rapidly.

The little fellow was exceedingly conscious of his peculiar appearance and was very sensitive about his nickname of 'tembo', the Kiswahili word for elephant.

His appearance can be judged from the snapshots I took before operation (*Fig.* 134, A, B). His nose merged into the upper surface of a swelling the size of a large grape-fruit, which replaced his upper lip. This swelling overhung his mouth, lower lip, and chin, and rendered his speech indistinct. When he was eating he liked to creep into a corner so that he could not be seen lifting the lump in order to slip the food into his mouth. The upper incisors, instead of forming an arc with the other teeth, were curved inwards, thus testifying to the pressure that was present during the growth of the second dentition.

OPERATION.—Intravenous cyclonal was given by my Indian Assistant, Dr. P. V. Gokhale, and the lump was open, I received a squirt of Indian-ink-like fluid. I sent the specimen to Dr. F. W. Vint, of the Medical Research Laboratory, Nairobi, who very kindly examined it and reported as follows :—

"The tumour is undoubtedly a melanoma. Microscopically there is no evidence of true cyst formation, but there is cystic degeneration. The pigment is so dense that it is impossible to see the details of the cells involved and it has diffused into the surrounding fibrous tissue. It is impossible to form any opinion of the degree of malignancy, and cystic degeneration is not uncommon in these tumours in the African."

Full details were taken of the boy's village, headman, and chief, and the boy's father, on receiving reprints of

A B C

FIG. 134.—A B, Photographs of patient prior to operation, showing the size of the tumour; C, Photograph of patient after removal of the tumour.

removed. It was found to be melanomatous and it spread down to both the nasal septum and the maxilla, but did not involve either. When the whole of the lump had been excised the gap was filled in by excising wedges of tissue on each side of the nose and cutting through the cheek at the angles of the mouth and then approximating the two resulting flaps to form the upper lip.

PROGRESS.—The boy was fed on native porridge for the first few days after the operation and the mouth and the buccal aspect of the wound were irrigated with a gentle stream of potassium permanganate lotion to remove food debris. The wound healed quite readily and the photograph shown in *Fig.* 134, C was taken three weeks after operation.

THE SPECIMEN.—I had been surprised at operation to find that the tumour was a melanoma and was still more surprised after operation, when, on cutting the lump the photographs, promised most faithfully that he would bring the boy for inspection after six months. When, however, in June, 1945, Dr. A. G. Farr, the Medical Officer then in Mwanza, attempted to get in touch with the boy, the chief reported that he and his father had been away from the village for some months and no one knew of their whereabouts. I regret that I am therefore unable to say with certainty that there has been no recurrence, but in view of the congenital nature of the tumour and the fact that a year has now passed and the boy has not returned to hospital for further treatment, as he most certainly would have done had the growth recurred, I think it may be assumed that the tumour was probably a benign melanoma. The more rapid increase in size during the few months before I saw him was probably due to cystic degeneration.

ACUTE DIAPHRAGMATIC HERNIA ASSOCIATED WITH INTESTINAL OBSTRUCTION

BY I. M. ORR

HON. SURGEON, HASLEMERE AND DISTRICT HOSPITAL

IN the very extensive literature on the subject of diaphragmatic hernia much attention has been paid to the chronic types of hernia, particularly to those of the para-œsophageal type, and it would seem that the condition is by no means rare. Harrington (1939) reports a personal experience of 210 cases and describes the aetiology, symptomatology, and X-ray diagnosis. He describes also the complications met with such as hæmorrhage and peptic ulceration.

There are numerous reports in the literature of diaphragmatic hernia of traumatic origin and the experience of the war will add greatly to the number. Cameron (1939) describes a case occurring thirty-two years after an old injury, and Swiney (1942) a case of acute herniation of the stomach through the diaphragm immediately following a stab wound of the chest. Laws (1944) reports a traumatic rupture through the right side of the diaphragm, which is

unusual, and Harper (1942) reports a case of left-sided traumatic rupture where the mediastinal pleura was completely torn and both sides of the chest were thus opened, recovery followed operation.

There are only a few references to strangulation of the herniated viscera. Deaner (1943) reports a case where the stomach and omentum had herniated through a para-œsophageal hiatus and had become strangulated. There was an associated hæmothorax.

The most comprehensive classification of the various types of diaphragmatic hernia is given by Dunhill (1939). He divides the cases into :—

a. Herniation due to a congenitally short œsophagus.

b. Œsophageal hiatus hernia.

c. Hernia through a developmental communication between the abdominal and pleural cavities.

d. Hernia through the foramen of Morgagni.

e. Hernia through the musculature of the diaphragm, possibly due to sneezing or coughing.

The influence of increased intra-abdominal pressure has been stressed by Ude and Rigler (1929), who noticed that diaphragmatic hernia was more common among women, especially those who had born children or suffered from ascitis or a large intra-abdominal tumour or cyst.

Rigler and Eneboe (1935) examined a series of 195 pregnant women and found that 18·1 per cent had some degree of herniation through the diaphragm.

The case about to be recorded is of interest in that it appears to have been precipitated by increased pressure due to acute intestinal obstruction; a congenital defect being present.

CASE REPORT

On Jan. 17, 1938, a young woman, aged 19, was admitted to the Haslemere and District Hospital with all the signs and symptoms of peritonitis. At operation a perforated appendix was found with free pus in the peritoneal cavity. The appendix was removed and the abdomen drained. The patient recovered and kept well till Jan. 27, 1944, when she was readmitted with an attack of acute abdominal pain and vomiting. The abdomen was slightly distended, but the scar of the old drainage tube in the left iliac fossa was markedly retracted. The abdomen was opened through a left paramedian incision and an adhesion causing obstruction was divided. The patient made a good recovery and remained well till Feb. 21, 1945, though she complained occasionally of a feeling of discomfort round the left lower ribs.

On Feb. 21, she was awakened by severe abdominal pain, most marked on the left side. The pain radiated round the left lower ribs and was referred to the left shoulder tip. The abdomen was not distended, but was slightly tender on the left side. There was nausea but no vomiting.

On Examination.—The left chest was tympanitic on percussion and gurgling sounds were heard in this region but no breath sounds. There was marked dyspnœa and the trachea was pushed to the right. The pulse was 84, and the respirations 24, temperature normal.

X-ray examination of the abdomen showed dilated coils of small intestine in the left hypochondrium. Radiography of the chest (*Fig.* 135) revealed a pneumothorax on the left side with complete collapse of the lung, and fluid levels at the base. The outline of the left dome of the diaphragm was blurred.

Later the same day, as nausea became worse, a Ryle's tube was passed into the stomach and 40 oz. of fluid were aspirated. A second radiograph of the chest was made with the tube in situ, and it was seen to enter the pleural cavity. A diagnosis of acute diaphragmatic hernia was made and the patient prepared for operation.

Operation.—Paravertebral block anæsthesia supplemented by positive pressure gas and oxygen was employed. The left 8th rib was resected, the pleural cavity opened, and the ribs widely spread. The left pleural cavity was completely filled with the grossly distended stomach and

Fig. 135.—Condition of lung on first admission. Left lung completely collapsed. Pneumothorax would be diagnosed but for the presence of the Ryle's tube in the thoracic cavity. The mediastinum is displaced to the right.

transverse colon. Air was evacuated from the stomach, and the deflated viscus and colon were then, not without difficulty, returned to the abdomen.

The opening in the diaphragm was 2½ in. long and 1½ in. wide, and was situated in the left dome between the attachments of the costal and vertebral portions. There was no peritoneal sac.

The edges of the diaphragm were approximated with chromic catgut interrupted sutures reinforced with a floss silk running suture. The left phrenic nerve was found and crushed, causing an immediate paralysis of the left dome of the diaphragm.

The chest wound was closed in layers, a small water-sealed drain having been placed in the 9th interspace in the paravertebral gutter.

Post-operative recovery was uneventful so far as the lung was concerned. It expanded rapidly, the pleural air being expelled through the water-sealed tube.

The day following the pleural operation, however, the abdomen was seen to be distended, vomiting was present and the picture was one of high intestinal obstruction. In view of the lung operation, however, efforts were persisted in to maintain the patient's condition by gastric aspiration combined with intravenous therapy.

Second Operation.—On Feb. 26, that is three days after the pleural operation, an operation for the relief of the intestinal obstruction became imperative and

through a left paramedian incision the abdomen was explored. The gut was adherent, some coils being collapsed and some congested and distended. During the process of freeing adhesions and attempting to relieve the obstruction a sudden leak of fæcal matter appeared. This was aspirated and the leak closed with interrupted sutures. Further attempts to free adhesions were abandoned and an entero-anastomosis performed between the bowel above and the bowel below the obstruction. Sulphanilamide powder was dusted into the abdominal cavity and the abdomen closed with a drain to the site of the repaired leak.

FIG. 136.—During convalescence from first and second operations shoulder-tip pain suggests a recurrence of the hernia and barium meal shows a portion of the fundus of the stomach herniated through the diaphragm.

The drainage was free from the outset and later a fæcal fistula developed. The general condition rapidly improved, and by the fifth day the bowels acted naturally. The fistula was troublesome, however; it healed and broke down on several occasions.

A month later a radiograph of the chest showed the lung completely re-expanded. The left dome of the diaphragm was still high. During convalescence the patient repeatedly complained of pain around the left ribs and sometimes of left shoulder-tip pain. She stated that this was the type of pain she had had for several years and that it had become more severe just before her admission.

Suspecting a recurrence of her hernia, a barium meal was given on April 4, and a small portion of the fundus of the stomach was seen to be herniated through the left dome of the diaphragm.

There was no evidence of intestinal obstruction. As the patient was averse to further operative interference and suffered very little inconvenience, she was discharged from hospital and, apart from occasional leakages from the fæcal fistula, lived a normal life for three months. As time went on, however, the shoulder-tip pain became worse and she had to sleep in Fowler's position to obtain relief.

THIRD OPERATION.—On July 3, the patient was re-admitted to hospital for closure of the fistula. The operation was uneventful, except that the patient strained and coughed badly under the anæsthetic.

The following day the shoulder-tip pain was severe, but the respiration was not embarrassed. There was nausea and a feeling of fullness in the stomach relieved by belching. The following morning the patient was in great distress. The pain was now in the left side of the thorax, the pulse-rate was 96 and of poor quality. The face was pale and the nausea and retching severe. As the day progressed the condition deteriorated. The apex beat became impalpable and the trachea was displaced to the right.

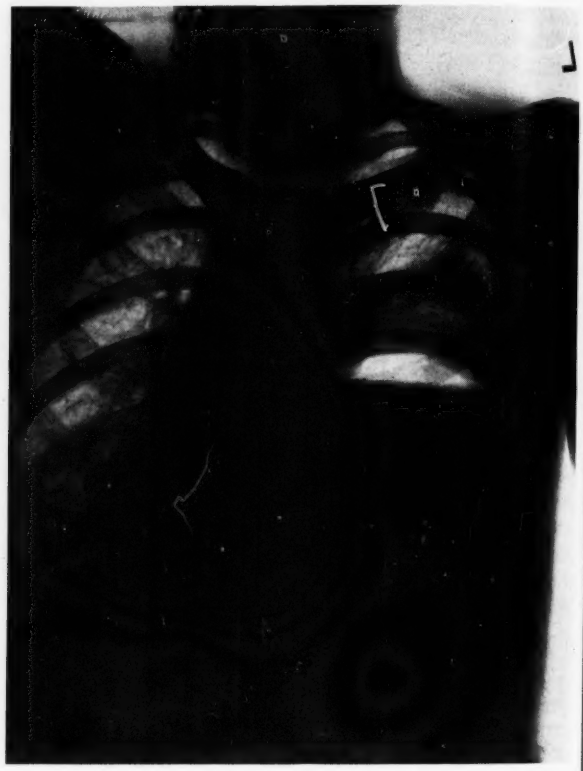


FIG. 137.—Condition on second occasion of acute herniation. The mediastinum is displaced to the right. The fundus of the stomach extends to the 7th rib and there is a fluid level in the stomach. Later the same day the stoamch and colon came to occupy the whole of the left side of the thorax.

Radiography of the chest (*Fig.* 137) showed marked mediastinal shift to the right. The fundus of the stomach was seen above the diaphragm with a well-marked fluid level. The left lung appeared to be compressed, but not collapsed. Attempts to pass a stomach tube into the stomach failed.

FOURTH OPERATION.—Operation for reduction of the hernia became imperative. Paravertebral block and positive-pressure gas and oxygen anæsthesia was again employed and the pleura opened through the old scar.

The pleural sac was completely filled with stomach, colon, and omentum. The stomach was greatly distended with dark brown fluid which had to be evacuated with a sucker and cannula before any attempt at reduction could be made. As soon as the stomach collapsed the rent was inspected. It was at the same site as the former hernia, but was smaller in size. There was no peritoneal sac, but the edges of the hernia were covered with a serous membrane. The viscera were returned to the abdomen not without difficulty and the edges of the rent overlapped with mattress sutures. Floss silk was then employed to interlace the scar area completely.

The left lung was completely collapsed, but at one point it was adherent to the old scar. The adhesion was divided. A water-seal drain was introduced through a

stab puncture in the 9th interspace and the thoracic wound sutured. Considerable quantities of air were bubbled through the water-seal and aspiration of the chest was carried out to promote re-expansion of the lung.

The following day the patient was much better, though she had a slight cough and hæmoptosis.

On July 7 X-ray examination showed that in spite of aspiration the mediastinum was still displaced to the right and there was complete pneumothorax. The patient's general condition improved daily and aspiration of air was persevered with.

On July 18, X-ray examination showed less displacement and some re-expansion of the lung. A fluid level was seen at the base.

On July 26, X-ray examination showed the mediastinum restored to its normal position, but the lung had not expanded completely and two fluid levels could be discerned, apparently due to a plastic pleurisy. Barium given in the supine position showed the fundus of the stomach in its normal position below the diaphragm and no tendency to herniation.

The patient steadily improved and the temperature, which had been raised during the first fifteen days, returned to normal. On Jan. 9, the patient was well and free from pain and attended the out-patient department for breathing exercises to mobilize the left side of the chest.

Radiography showed lung fully expanded and complete absence of fluid level.

DISCUSSION

This case is of especial interest, showing as it does the part increased intra-abdominal pressure may play in inducing diaphragmatic hernia. It seems most probable in this case that there was a congenital weakness of the diaphragm and possibly a small hernia of many years' standing. This is the more likely as the patient admits that left shoulder-tip pain and pain around the lower left ribs were often experienced in the years between her original appendix operation and the onset of acute obstruction.

Following the first pleural operation, the early recurrence of a small hernia of the fundus of the stomach might have been due to faulty technique in the suturing of the diaphragm, but no doubt the increasing distension of the intestines due to obstruction put an unusual strain on the recently sutured diaphragmatic hernia before the processes of repair had had time to develop. Furthermore, during the operation for closure of the fæcal fistula the straining under the anæsthetic was sufficient to precipitate a complete prolapse of the viscera.

In discussing the operative procedure, it may be argued that an operation to relieve obstruction should have been undertaken before attempting to deal with the hernia, but it must be remembered that the symptoms of the pleural condition completely overshadowed the abdominal lesion.

Further, it might be argued that when a small portion of the fundus of the stomach was seen to have herniated after the first pleural operation it ought to have been repaired forthwith. No doubt it should, but as a small herniation is a common condition causing little inconvenience it seemed reasonable to assume that this small herniation would give no further trouble.

SUMMARY

1. The incidence and classification of diaphragmatic hernia is discussed.

2. Reference is made to the part increased intra-abdominal pressure plays in precipitating hernia.

3. A case of acute herniation associated with acute intestinal obstruction is described and the operative procedure and complications outlined.

REFERENCES

CAMERON, J. A. M. (1939), *Lancet*, **1**, 757.
DEANER, S., et al. (1943), *Brit. med. J.* **1**, 16.
DUNHILL, T. (1939), *St. Thomas's Hosp. Gaz.*, **37**, 112.
HARPER, F. R. (1942), *Ann. Surg.*, **116**, 938.
HARRINGTON, S. W. (1939), *Calif. west. Med.* **50**, 399, **51**, 27.
LAWS, H. W. (1944), *Canad. med. Ass. J.*, **50**, 62.
SWINEY, J. (1942), *J. Roy. Army med. Cps.*, **79**, 297.
RIGLER L. G. and ENEBOE, J. B. (1935), *J. thorac. Surg.*, **4**, 262.
UDE, W. and RIGLER, L. G. (1929), *Minn. Med.*, **12**, 751.

CONGENITAL FUSION OF LUNATE AND TRIQUETRUM

BY J. F. CURR

TEMPORARY ASSISTANT SURGEON, ROYAL INFIRMARY, EDINBURGH, AND LEITH HOSPITAL

Two examples of this congenital abnormality were seen by me in the Royal Infirmary, Edinburgh, in 1944. The first patient, a woman aged 63, attended on account of a needle which had become embedded in the left hand and which was subsequently removed (*Fig.* 138). The second patient, a man aged 35, had received a slight injury to the right wrist no fracture being present (*Fig.* 139). In both cases X-ray examination showed, on one side only, a complete fusion of the lunate and triquetrum, which was obviously a congenital abnormality and was not due to any acquired cause. At no time had there been any reason to suspect that the wrists were anything but normal, and the discovery of the abnormality was purely accidental.

This condition of congenital fusion of the lunate and triquetrum is undoubtedly very rare and is of little real importance as it does not interfere with the external appearance or function of the wrist. McGoey (1943) was unable to find a previous reference to the anomaly when he reported a unique case of a fracture of the triquetral part of the fused bone along with a dislocation of the carpus; an excellent result was obtained after reduction of the dislocation. White (1944) recorded the anomaly of fusion of the capitate and hamate, the X-ray appearances being similar to the present cases.

I am indebted to Dr. R. McWhirter for the radiological examinations.

REFERENCES

MCGOEY, P. F. (1943), *J. Bone J. Surg.*, **25**, 928.
WHITE, E. H. (1944), *Amer. J. Roentgenol.*, **52**, 406.

FIG. 138.—Fusion of lunate and triquetrum; also needle in hand.

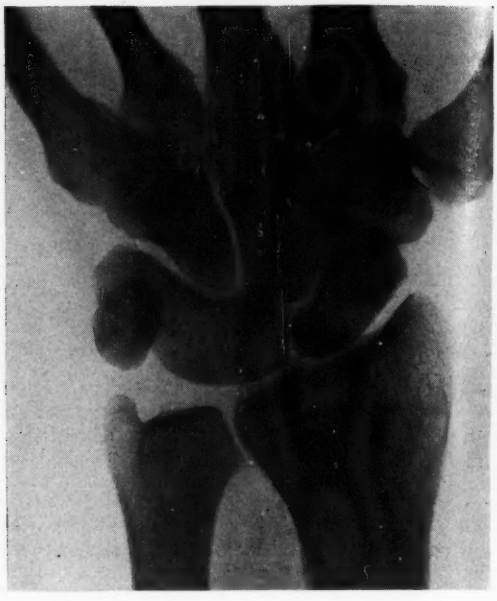


FIG. 139.—Fusion of lunate and triquetrum.

A CASE OF CHRONIC BILATERAL SUBPHRENIC ABSCESSES

BY SURGEON LIEUTENANT H. H. BENTALL, R.N.V.R.

THIS case shows an unusual and perhaps unique complication of acute appendicitis—the development of chronic bilateral subphrenic abscesses with extension of that on the left into the pleural cavity.

CASE REPORT

April 6, 1944: While serving overseas, an able seaman, aged 32, was admitted to hospital with acute appendicitis of two days' duration. At immediate operation a moderate amount of purulent exudate was found in the right paracolic gutter and a ruptured gangrenous appendix was removed. The post-operative course was stormy. He was nursed in Fowler's position for the whole of this time. After one month symptoms of left-sided pleurisy developed, with radiological evidence of a small basal effusion. A radiograph two weeks later was said to show "some residual reaction at the left base". On discharge early in June his temperature had been normal for two weeks and he had no specific complaints.

After a period of convalescence he served at sea until:—

Oct. 28: He fell down a ladder in heavy weather. There was no severe injury, but next day he complained of pain in the left side of the chest on deep breathing and began to have a dry cough.

Two days later he was admitted to hospital, obviously ill, with a swinging temperature up to 103° F., and raised pulse and respiration rates. There was tenderness over the lower ribs both in front and behind and evidence of left-sided pleurisy with effusion. No physical signs were noted in the abdomen and the appendix scar was said be be sound. Radiography showed a basal effusion up to the level of the neck of the fifth rib. There was no evidence of fractured ribs. The white-cell count was 18,000. Aspiration revealed "a heavily blood-stained fluid, flecked with pus and of foul odour". The Gram film showed "pneumococci and short-chain streptococci". The result of culture was not stated. The condition was thought to be one of infected traumatic hæmothorax.

Aspiration was carried out frequently in the succeeding three weeks, during which time the fever and leucocytosis continued.

Nov. 21: The resultant empyema was drained by rib resection. The patient's condition slowly improved and the cavity became steadily smaller.

March 14, 1945: He next complained of discomfort in the right iliac fossa. After three days a tender mass became palpable deep to the healed (McBurney) scar of the appendicectomy. This discharged spontaneously thick pus devoid of organisms and sterile on culture.

May 5: He was transferred to a Royal Naval Auxiliary Hospital, where he came under the care of the writer. He was an ill patient, thin and pale. There was no pyrexia.

A small sinus was discharging thick creamy pus at the site of rib resection. There was a small bronchopleural fistula. The sinus opening in the appendicectomy scar was also discharging thick pus.

A pleurogram (*Fig.* 140) showed a small residual empyema cavity with a bronchopleural fistula.

The case was considered to be one of right-sided subphrenic abscess and left-sided empyema due to infected traumatic hæmothorax.

TREATMENT AND SUBSEQUENT COURSE.—

May 8: *Redrainage of Chronic Empyema.* The cavity was explored but no ramifications were found after careful searching. All regenerated rib was resected and a large-bore rubber tube inserted. Vigorous breathing exercises were commenced.

June 3: Lipiodol examination of the abdominal sinus revealed a tortuous intraperitoneal track leading from the right iliac fossa to a large cavity in the right posterior superior subphrenic space (*Fig.* 141).

June 5: *Drainage of Right Subphrenic Abscess.* The abscess was approached extra-serously through the bed

of the twelfth rib at the level of the first lumbar spine (Ochsner and Graves, 1933). A cavity was entered and found to contain 10 oz. of evil-smelling pus. Digital exploration revealed a unilocular cavity about the size of an orange. A large rubber tube was inserted around the empyema sinus communicated with the left posterior subphrenic space, and that the elevation of the diaphragm, present to a lesser degree previously, was, in fact, due to a left subphrenic abscess and not to retraction following the healing of the empyema.

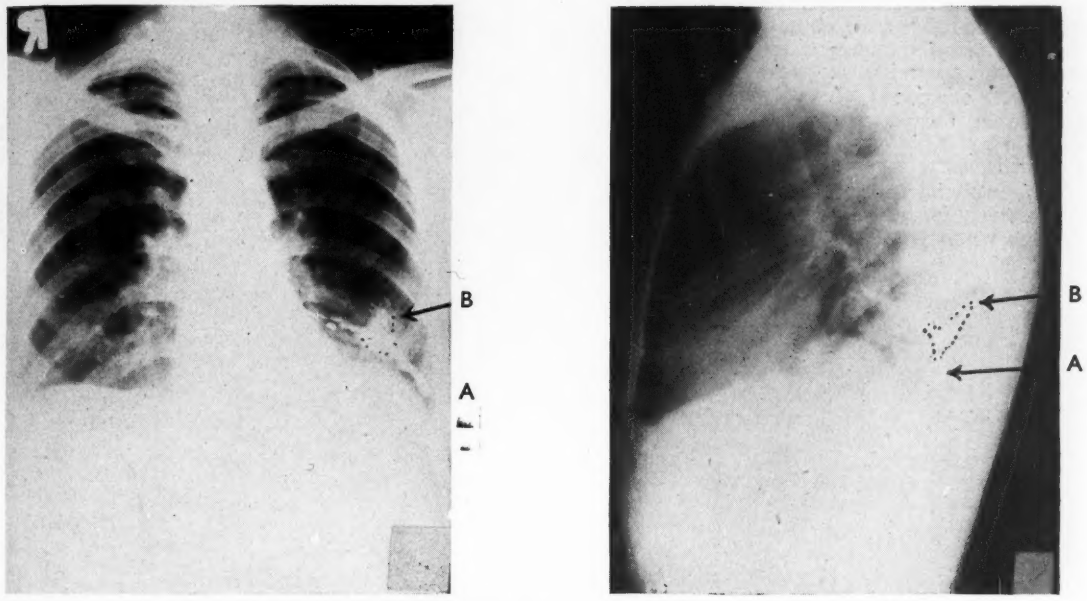


FIG. 140.—Anterior-posterior and left lateral pleurograms showing small residual empyema cavity with a broncho-pleural fistula. A, Skin marker at sinus; B, Extent of empyema cavity.

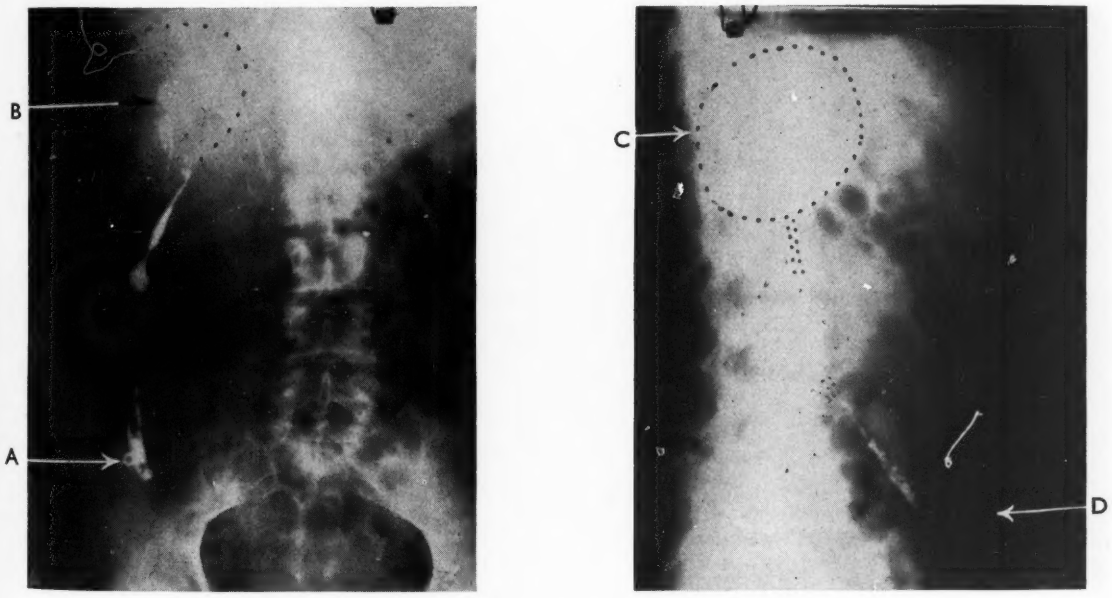


FIG. 141.—Postero-anterior and right lateral radiographs showing track from abdominal sinus to right subphrenic space. A, Marker on skin sinus; B, Lipiodol in right suphrenic space; C, Abscess cavity; D, Opening of sinus on to skin.

which the wound was closed. Two days later discharge from the abdominal sinus ceased and has not since recurred. Progress was rapid and the patient soon became ambulant.

Aug. 23: The empyema wound, which had been healed for a month, began to discharge and tenderness was present over the left twelfth rib. A further lipiodol examination was performed (*Fig.* 142). This showed that

Aug. 27: *Drainage of Left Subphrenic Abscess.* The outer half of the eleventh rib was resected. The adherent visceral and parietal pleuræ were separated from one another over the dome of the diaphragm until the abscess was palpable. The cavity was opened, its wall being at least ½ in. thick. Digital exploration again revealed a unilocular cavity about the size of an orange. A large rubber tube was inserted and brought out through a

separate stab wound adjacent to the main incision, which was sutured.

Primary healing ensued. The chest wall sinus from the empyema ceased to discharge immediately and soon closed.

PATHOLOGICAL INVESTIGATIONS.—From the onset of the acute empyema in October, 1944, until after drainage of the right-sided subphrenic abscess in June, 1945, there was a leucocytosis of 18,000 or more. The blood-count 17 days after this operation was as follows :—

Red cells, 4,000,000
Hæmoglobin, 80 per cent
Colour index, 1·0
White cells, 8400
Polymorphonuclears, 64 per cent
Lymphocytes, 30 per cent
Large monocytes, 4 per cent

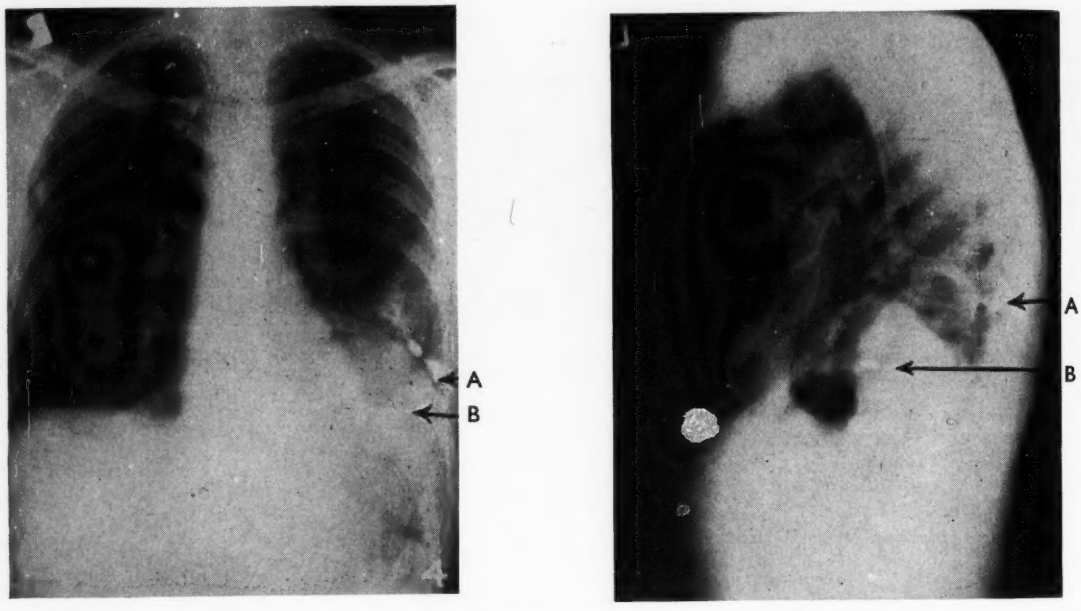


FIG. 142.—Postero-anterior and left lateral pleurograms showing elevation of left diaphragm and evidence of communication between left empyema sinus and left subphrenic space: A, Lipiodol in empyema sinus ; B, Lipiodol in subphrenic space.

In August, 1945, just before drainage of the left-sided subphrenic abscess, the blood-picture was unchanged.

Bacteriology.—At the first aspiration of the empyema the stained film showed pneumococci and short-chain streptococci. There is unfortunately no record of the result of culture at this time. Subsequent examinations of pus gave *negative* results as tabulated below.

SOURCE	FILM FOR TUBERCLE BACILLI	FILM FOR ACTINOMYCES	AEROBIC AND ANAEROBIC CULTURE
Abdominal sinus	13 times	10 times	7 times
Empyema	5 times	5 times	5 times

A section of pleura taken at the time of redrainage of the empyema showed no evidence of tuberculosis, and inoculation of a guinea-pig with pus from the abdominal sinus was negative.

END-RESULT.—Obliteration of all the abscess cavities following adequate drainage was rapid. The patient's general condition steadily improved and he was finally discharged from hospital in December, 1945, entirely free from symptoms.

DISCUSSION

Ochsner (1938), in a review of 3583 cases of subphrenic abscess, describes three broad types of onset :—

1. Those of sudden onset (14 per cent), showing symptoms in two or three days from the initial infection.

2. The common type (70 per cent), showing fever and leucocytosis after 10 to 21 days.

3. Those of insidious onset (16 per cent), showing, as a rule, only general symptoms such as malaise commencing after many weeks or months. It is into this group that the present case falls.

Discussing the aetiology of left-sided abscess, Neuhof and Schlossmann (1942) have shown in an analysis of 33 cases that the source of infection is usually local rather than remote, as on the right side. They report 2 cases resulting from appendicectomy and pelvic suppuration, which they ascribe to lymphatic rather than to direct intraperitoneal or retroperitoneal spread ; and a further 2 cases resulting from pelvic suppuration by way of a retroperitoneal track over the sacral promontory along the psoas muscle. They conclude that there are no pre-existing specific pathways of infection to the left subphrenic space, and that suppuration beneath the left diaphragm is contingent upon direct extension from regional areas in most cases.

The association of empyema with subphrenic abscess is well known. It is, however, relatively more common on the right side owing to the fixity of the liver. On the left side, by contrast, the freely mobile stomach and spleen offer less resistance. Elevation of the diaphragm, an inconstant accompaniment of subphrenic suppuration, is for the same reason more likely to occur on the right.

In this case, however, the left diaphragm was markedly domed and the right showed no elevation.

At all times both sides of the diaphragm moved well in a normal direction on screening.

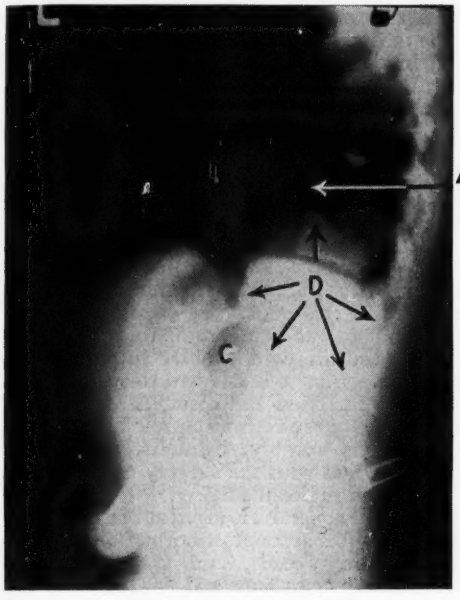


FIG. 143.—Left lateral radiograph following barium meal, showing relation of abscess to stomach and colon: A, Elevated left diaphragm; B, Gas in stomach; C, Gas in colon; D, Abscess.

In this case the right-sided abscess was probably caused by the intraperitoneal spread of infection along the right paracolic gutter, along which route, in reverse, it later discharged. If this assumption is correct, it seems likely that the left-sided abscess was also due to direct intraperitoneal infection, in this instance by way of Morison's pouch to the lesser sac. The close relation of the abscess to the lesser sac was confirmed by the relative positions of the stomach, abscess, and transverse colon, as seen in the left lateral film following a barium swallow (*Fig.* 143).

It is interesting that apart from a 'stormy convalescence', the only specific symptoms referable to the subphrenic region were those of a left basal pleurisy at one month. Shoulder pain was constantly absent. Extension of the left-sided abscess into the pleural cavity appeared to be precipitated by a fall, although this might have occurred spontaneously in the course of time.

SUMMARY

A case is described of acute appendicitis followed by chronic bilateral subphrenic abscesses and left-sided empyema thoracis. The diagnostic and operative measures employed are detailed and the aetiological factors concerned are briefly discussed.

I wish to thank the Medical Director-General of the Royal Navy and Surgeon Rear-Admiral C. H. M. Gimlette for permission to publish this account, and Surgeon Captain J. Hamilton, R.N., for his help and encouragement.

REFERENCES

NEUHOF and SCHLOSSMANN (1942), *Surg. Gynec. Obstet.*, **75**, 751.
OSCHNER and DE BAKEY (1938), *Int. Abstr. Surg.*, **66**, 426.
— and GRAVES (1933), *Ann. Surg.*, **98**, 961.

REVIEWS AND NOTICES OF BOOKS

L'Urographie Intra-veineuse (U.I.V.). By BERNARD FEY and PIERRE TRUCHOT. $9\frac{7}{8} \times 6\frac{3}{8}$ in. Pp. 213 + viii, with 242 illustrations. 1944. Paris: Masson et Cie. 320 fr.

WHEN the new diagnostic method of intravenous urography was first described by Von Lichtenberg and Swick in 1929, its advantages were so patent that it soon became widely adopted. Its application on a large scale has, however, been somewhat slipshod both in radiological technique and in the interpretation of the urograms, and there is no doubt that its full possibilities have not yet been exploited. The present work is a critical evaluation of the method based on and illustrated by numerous cases, and whilst it forms a useful atlas of intravenous urography, it is from the accompanying text that both the clinician and the radiologist will derive the most benefit.

Professor Fey, originally an opponent of compression for artificially increasing the radiological shadow, now comes forward as one of its most ardent advocates. He uses the delayed compression technique of Colliez, in which compression is applied after the first film of secretion has been taken and is maintained for 10 to 15 minutes. Another film is then taken immediately after decompression. Recognizing the errors which may be introduced by compression, he is convinced that they are avoided by the film after release and he claims that the lower ureters are best demonstrated by this technique, a claim which is amply supported by the illustrations.

The authors are of the opinion that some films are radiologically valueless owing to faulty technique, whilst in some the urinary concentration is insufficient to give a shadow. In the latter group the fault is often due to lack of co-operation between the urologist and the radiologist, and to overburdening the X-ray department with three or four cases to be completed in two hours, apart from other examinations. If the investigation is to yield the fullest information it makes great demands on the time of both the clinician and the radiologist, who must be prepared to modify the times of the films according to the circumstances of the individual case. Given such collaboration the cases where one must have recourse to pyelography are few.

The results illustrated justify the care demanded and make one feel that we have not as a whole in this country made the best use of intravenous urography. An English translation of this work would fill a great gap.

Published in France in 1944, the book is well produced and on paper of excellent quality. It lacks a bibliography, and the index might well be extended; it is worthy of something stronger than a paper cover, but its perusal is well worth the two hours taken in cutting the pages.

Hospital Care of the Surgical Patient. By GEORGE CRILE, jun., M.D., Surgeon, Cleveland Clinic, and FRANKLIN L. SHIVELY, jun., M.D., Assistant Surgeon, Cleveland Clinic. With a Foreword by EVARTS A. GRAHAM. Second edition. 8⅛ × 5⅜ in. Pp. 288 and 18, with 25 illustrations. 1946. Springfield, Ill.: C. C. Thomas. (London: Baillière, Tindall & Cox.) 14s. net.

THE fact that a second and enlarged edition of this book has been required within three years of its first appearance testifies to its usefulness. A book like this is of value not only for the instruction of House Officers but also because it records for the benefit of the world at large what is the practice of the Cleveland Clinic at the present time. Fashions change in surgical care as in everything else, and revisions will be needed as the years go by: we may therefore look forward to many more editions in future.

It is one thing to lay down certain rules and orders with the object of standardizing hospital procedure, but here we have set out the physiological and biochemical principles upon which the authors have based their practice. The book covers a wide field in 'general' surgery, but it may be that in future editions details of the management of thoracic and cerebral cases before and after operation can be included. The true 'specialties' should perhaps still be excluded for fear of making the book too bulky and throwing it out of balance. Even now the arrangement of Section II on Surgical Complications seems to be rather haphazard. Most of the descriptions of the technique of treatment are clear and adequate, but it seems doubtful if the gastric suction apparatus, as illustrated, would work.

There is a useful appendix indicating how the lessons learnt during the war about the treatment of wounds can be applied to the problems of civilian surgery.

A Manual of Surgical Anatomy. Prepared under the auspices of the Committee on Surgery of the Division of Medical Sciences of the National Research Council, by TOM JONES, Professor of Medical and Dental Illustration and Head of Department of Illustration Studios, University of Illinois Medical School, and W. C. SHEPARD, Art Editor, W. B. Saunders Co. 10¾ × 8 in. Pp. 195 + xvi, with 267 illustrations, 153 in colour. 1945. London and Philadelphia: W. B. Saunders Co. Ltd. 25s. net. Pocket edition also available.

THIS is an atlas rather than a manual in the accepted sense of the term. It has been produced primarily to help war surgeons, but it will undoubtedly find a useful place amongst others. The illustrations are line drawings with shading; colour is used only when necessary for clarification and is never blatant. The pictures are very good, and their labelling is excellent. Standard English terminology is used, but the equivalent B. N. A. terms are given in the comprehensive explanatory index.

We can strongly recommend this as an atlas of surgical anatomy, and its price at the present time is most reasonable.

Principles and Practice of Surgery. By W. WAYNE BABCOCK, M.D., Emeritus Professor of Surgery, Temple University; Acting Consultant, Philadelphia General Hospital. With the collaboration of 37 Members of the Faculty of Temple University. 10⅛ × 6½ in. Pp. 1331, with 1141 illustrations. 1946. London: Henry Kimpton. 60s. net.

THIS is a large, comprehensive volume of some thirteen hundred pages, covering the whole realm of surgery. The author has wisely recognized the weakness of single authorship and has made use of thirty-seven collaborators drawn from the special departments of the Temple University. There is surprisingly little overlapping of chapters and this is probably due to the able editorship of Professor Babcock, who is known the world over for his well-known *Textbook of Surgery*.

The illustrations, which number 1141, are excellent and for the most part are original and stimulating. There has been, in the past, too great a tendency for authors to make use of dated pictures and drawings and to borrow blocks from other text-books. It is refreshing, therefore, to find such wealth of new, original illustrations in this volume.

During the second World War surgical treatment received a very definite stimulus, and trial of new methods on a large scale was available. The outcome of this can be seen in the remarkable results obtained from penicillin in syphilis, gonorrhœa, and streptococcal and staphylococcal infections. These new methods of treatment are well described in this book.

The lay-out of the contents of this volume is rather novel. *Part* 1 deals with general surgery and is very well presented. *Part* 2 is devoted to surgical technique, which includes infection and disinfection, surgical therapeutics, bandaging, anæsthesia, pre- and post-operative treatment, plastic surgery, ligations, and amputations. *Part* 3 is concerned with the surgery of the systems, and *Part* 4 deals with regional surgery.

A most useful appendix is given at the end of the book; this gives a very full account of normal blood, its volume, viscosity, hæmocrit, cells, and chemical constituents. This ready reference to facts and figures will be welcome to all surgeons who cannot carry these detailed facts in their heads.

A very comprehensive bibliography completes this useful and practical volume.

Professor Babcock is to be congratulated on his latest book; it is a real credit to himself and his co-workers at Temple University.

Injuries and Diseases of the Œsophagus. Being the George Haliburton Hume Memorial Lectures. By G. GREY TURNER, Professor of Surgery in the University of London at the British Post Graduate Medical School. 8½ × 5½ in. Pp. 100 + viii, with 19 illustrations and 8 plates. 1946. London: Cassell & Co. Ltd. 15s. net.

THESE are two lectures delivered in 1943 by Professor Grey Turner, in which he pays tribute to the memory of his teacher, George Haliburton Hume, a surgeon to the Royal Infirmary, Newcastle, who died twenty years previously.

In these two lectures Grey Turner tells much of his personal experiences in the surgery of the œsophagus, a branch of surgery which had fascinated him for many years and compelled him to think and study. He tells the story of successes and failures in a very human and anecdotal manner, which is reminiscent of those clinical demonstrations for which the Professor is a past master.

Diseases of the Breast. By CHARLES F. GESCHICKTER, M.A., M.D., Commander, Medical Corps, U.S.N.R., with a Special Section on Treatment in collaboration with MURRAY M. COPELAND, A.B., M.D., F.A.C.S., Instructor in Surgery, Johns Hopkins Medical School; etc. Second edition. 9 × 6 in. Pp. 826 + xxvi, with 593 illustrations and 3 coloured plates. 1946. Philadelphia and London: J. B. Lippincott Co. 72s. net.

THE second edition of this well-known book has been thoroughly brought up to date in the light of recent advances in mammary conditions. The use of penicillin in the treatment of acute and chronic mastitis is well set out, and the treatment of chronic cystic mastitis by endocrine therapy is given its proper place.

The book is a useful and clear guide, covering every conceivable aspect of diseases of the breast. The illustrations are numerous and for the most part are good, but it is a pity that certain drawings have been included which are supposed to demonstrate clinical characteristics, and in that they fail miserably.

The statistical tables are very interesting and should prove of value to surgeons who wish to compare the results of treatment with other hospitals both in England and America.

The Traumatic Deformities and Disabilities of the Upper Extremity. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor and Head of the Department of Orthopædic Surgery, the State University of Iowa, in collaboration with JOHN LOUIS MARXER, M.D., Associate, Orthopædic Department, the State University of Iowa. 10 × 6½ in. Pp. 394 + xxi, with 443 illustrations. 1946. Springfield, Ill.: Charles C. Thomas. $10.00.

THE writings of Arthur Steindler are well known the world over, and the present monograph contains a wealth of clinical material that has passed through his clinic at Iowa. This is an age of trauma, with the increase in accidents due to aviation and mechanical transport.

The surgeon must of necessity be much more conservative with injuries of the upper extremity, as its main function is mobility, while the lower extremity demands stability before anything else.

In this monograph every type of traumatic deformity or disability is fully considered from every aspect. The importance of a correct diagnosis is stressed and the appropriate treatment given. The reviewer is pleased to see that conservative treatment has a high place in Professor Steindler's clinic.

Numerous case reports with radiographs increase the value of this volume; they always help to convince the reader of any particular difficulties which may arise and the way these difficulties may be overcome. The illustrations throughout this book are excellent and the clinical photographs deserve special praise. Good clinical photographs taken before and after operation will give much more information than any amount of text.

The importance of occupational therapy and rehabilitation are recognized and given their proper place in the treatment of injuries of the upper extremity.

This book will prove of real value to surgeons who have to deal with traumatic conditions, and it will also serve as a book of reference on this important subject.

The 1945 Year Book of Industrial and Orthopedic Surgery. Edited by CHARLES F. PAINTER, M.D., Orthopedic Surgeon to the Massachusetts Women's Hospital and Beth Israel Hospital, Boston. 7 × 4⅝ in. Pp. 432, with 225 illustrations. 1946. Chicago: The Year Book Publishers Inc. (London: H. K. Lewis & Co. Ltd.) 18s. net.

THE 1945 edition of this well-known volume contains much stimulating material, and not a little which will be regarded in this country as controversial. It is inevitable in a book of this nature that there will be articles and opinions which will not meet with universal approval; but on the whole the Editor has shown wise discrimination in the selection of contributions representative of present-day informed opinion. Though the articles extracted are predominantly American, some of the more important British contributions to this literature have been included.

During the period under review orthopædic interest was especially concerned with the problems of arthritis, osteomyelitis, fractures, and low back pain with sciatica. These fields are all soundly covered. In the section on rheumatoid arthritis the main emphasis is on the uncertainty of results and on the dangers of toxic reactions following gold therapy. The treatment is justified, however, by the fact that considerable relief is obtained in slightly more than half the cases treated. In discussing the treatment of acute hæmatogenous osteomyelitis with penicillin, the tendency is to recommend doses which in many British centres would be regarded as inadequate. The importance of early surgery in addition to chemotherapy is rightly stressed by more than one observer. The articles on fractures and other traumatic conditions are in the main sound. The omission of any reference to bone grafting by means of cancellous chips from the ilium is a little surprising. In the section on the spine it is clear from the diversity of opinions presented that the solution of the problem of sciatica and the retropulsed intervertebral disc has not yet become crystallized.

Industrial medicine is a comparatively new field, and several contributors emphasize the importance of adequate facilities for pre- and post-graduate training in the special problems involved. The notes on modern industrial hazards and occupational diseases will be of value.

Although from the title it might be thought that the industrial medicine would take up a considerable proportion of this book, this is an erroneous impression, since this section occupies only approximately one-eighth of the subject matter.

The X-ray Treatment of Accessible Cancer. By D. WALDRON SMITHERS, M.B., D.M.R., Director of the Radiotherapy Departments, The Royal Cancer Hospital (Free), and the Royal Free Hospital; etc. 10¾ × 7⅜ in. Pp. 147 + viii, with 102 illustrations. 1946. London: Edward Arnold & Co. 40s. net.

THIS is a book which is full of useful information to the surgeon, for it sets out in a very practical and lucid manner the real value of X-ray therapy in the treatment of accessible cancer.

The clinical records are excellent and it is to be hoped that all hospitals in which X-ray therapy is carried out will adopt the very thorough history sheets as advocated and used by the author. The use of clinical photographs are of real importance in assessing the value of any form of treatment, as the pre- and post-operative pictures can be compared, and in this volume full use of this form of recording has been made. Some coloured photographs have been included and are truly excellent.

The results of treatment of various forms of cancer by X rays are set out in a very practical and interesting way, and the reader cannot help being impressed with the good results obtained.

Two very useful appendices are to be found at the end of the book, one dealing with definitions and the other with isodose curves.

A very extensive and comprehensive bibliography, an author's index, and a subject index complete this useful and very readable book.

La Faculté de Médicine de Paris. Ses Origines, ses Richesses artistiques. By PIERRE VALLERY-RADOT. 8½ × 5½ in. Pp. 86 + vi, with 26 illustrations on 12 plates. 1944. Paris: Masson et Cie.

THIS is a beautifully got up and well-illustrated small book giving an account of the Faculty of Medicine of Paris, together with its origins and its artistic treasures. The book is of peculiar interest to surgeons because for centuries and up till the Revolution the Faculté de Médecine and the College de Chirurgie were two separate institutions, each having its school, its statutes, its professors, and its students. After the Revolution the two institutions were merged into one establishment, for the time called the Ecole de Santé, later to become the Faculty of Medicine.

The record of the College de Chirurgie detailed in this book is of undoubted interest to students of medical history.

The Early Diagnosis of the Acute Abdomen. By ZACHARY COPE, B.A., M.D., M.S. (Lond.), F.R.C.S. (Eng.), Surgeon to St. Mary's Hospital; etc. Ninth edition. 8⅜ × 5⅜ in. Pp. 262 + xv, with 38 illustrations. 1946. London: Geoffrey Cumberlege, Oxford University Press. 12s. 6d. net.

THERE is always a demand for a really good thing, and the fact that this is the ninth edition speaks for itself.

The seventh edition was reviewed in this JOURNAL in 1936 (April) and the eighth in 1940 (July). It must have given the author a peculiar satisfaction to have been able to write in the Preface of of this edition: "I have met many Doctors from the United States of America and from all parts of the British Commonwealth who have generously expressed their indebtedness to this little book. I would like to take this opportunity of letting them know how much pleasure and encouragement their testimony gave me".

The minor alterations and additions in this edition are few and have been carefully considered before inclusion by the author from his further experience.

The reviewer who considered this book in 1936 quibbled with the term 'acute abdomen'. He would "have vastly preferred the title to have been "The Early Diagnosis of Acute Abdominal Crises". If such advice had been taken then probably no subsequent edition would have yet been called for.

From an academic point of view "abdominal crises" sounds well, an exact diagnosis is desirable in all cases.

The busy practitioner, however, really wants what this book provides—namely, the facts and means whereby he can determine that the case is an 'acute abdomen' and to send it for surgical intervention rather than to try and unravel a crisis.

With this idea in view the author rightly devotes the first fifth of the book to the principles and methods of diagnosis before considering individual conditions which may give rise to the necessity for using them. He first of all stresses the history of the onset, and the previous history of the patient, and then the routine examination. It is well known how difficult this may be, both for the patient in acute pain and the practitioner, called out of bed from his well-earned rest at the end of a busy and tiring day.

Moreover, all vomited material and bowel discharge having been thrown away in preparation for the doctor's visit, the only diagnosis that often can be made is that of 'acute abdomen'.

How well fitted to the occasion are the words, "Having eyes, see ye not? and having ears, hear ye not? and do ye not remember.

It is little wonder that if an exact diagnosis is attempted the same mistake may be made for the *n*th time.

The author rightly stresses the uselessness of paying much attention to the pulse and temperature in the early stages. The bradycardia of the acute abdomen, and the low temperature resulting from the initial shock which is only slowly rising has lulled to sleep the clinical acumen of many, but if the pulse-rate is rising on the second visit then it is a matter of great importance.

The normal pulse-rate and temperature, together with the absence of rigidity in the early stage of an acute appendicitis in the pelvis, especially if the patient is a child, will deceive the most wary; as also will the physical signs when the patient is seen soon after the pain is relieved by rupture of the organ.

The description and explanation of the symptoms and signs of acute pancreatitis are very succinctly described, and it is a pity that the terms of reference of his title preclude the author from giving or at least indicating his treatment of this condition. He may possibly rely after a correct diagnosis on duodenal suction, agreeing with the writer of Ecclesiastes, that "A living dog is better than a dead lion". The use of a straight radiograph as often determining the diagnosis in acute intestinal obstruction is rightly stressed and the illustrations of its use are most convincing.

There is a short concise description of the rare condition of volvulus and the difficulties of diagnosing it from stricture of the large bowel, but no mention is made of the fact that the two conditions may be coexistent, and, in fact, when treating a case of volvulus the presence of a stricture in the distal gut should be borne in mind as a probable cause.

The early diagnosis of strangulated and obstructed herniæ is considered in a separate chapter from that upon acute intestinal obstruction, but it is rather difficult to agree with the statement, "It is usually a very easy matter to diagnose a strangulated hernia"—is it? The symptoms and signs making the diagnosis are those of the obstruction. Strangulation is really a pathological condition; in fact, obstruction is very rarely unassociated with some degree of strangulation or interference with blood-supply; at any rate, the prognosis certainly depends upon the latter and this can only be determined at the operation. Be that as it may! It might possibly be better not to use the terms more or less synonymously as is often the case. The opinion that "the hernia is obstructed but not strangulated" often accounts for the fatal outcome of the case.

The chapter on "The Acute Abdomen in the Tropics" is very concise and useful and will make a special appeal to many who during the recent years have been faced with the difficulties.

The tables detailing the differential diagnosis of the various pathological lesions accounting for and simulating the acute abdomen are most useful and helpful.

The book can be thoroughly recommended to all who in the course of their work meet the acute abdomen. It should also be read by the student doing his surgical dressing. He, unfortunately, usually sees the case when the diagnosis of an acute abdomen is very obvious. In the course of his work in practice he meets much more commonly the 'chronic abdomen' for which at present there is little room in hospitals, and when he meets the early acute abdomen it bears little resemblance to those he saw while in hospital.

To the house surgeon and those who have to unravel the crises, the book should be invaluable, a veritable *vade mecum*, but even so the adage that every acute abdomen should be opened with an open mind must never be forgotten.

Fractures of the Jaws. By ROBERT H. IVY, M.D., D.D.S., F.A.C.S., Professor of Plastic Surgery, School of Medicine, University of Pennsylvania; etc.; and LAWRENCE CURTIS, A.B., M.D., D.D.S., F.A.C.S., Associate Professor of Plastic Surgery, School of Medicine, University of Pennsylvania. Third edition, thoroughly revised. 9 × 5¾ in. Pp. 174, with 220 illustrations. 1946. London: Henry Kimpton. 22s. 6d. net.

THIS well-known monograph has now reached a third edition and thoroughly deserves its continued success. The last war gave a great impetus to the improved methods of treatment of jaw fractures. The new and varied types of apparatus built on the Roger Anderson model have facilitated in no small way to the excellent results that now obtain in fractures of the lower jaw.

This book is written in a lucid style, is comprehensive, and is practical to a degree. It should prove of real value to all interested in dental and traumatic surgery. The illustrations are numerous and of a high standard.

Demonstrations of Operative Surgery for Nurses. By HAMILTON BAILEY, F.R.C.S., Surgeon, Royal Northern Hospital, London; etc. 8½ × 5½ in. Pp. 348 + viii, with 531 illustrations, some in colour. 1945. Edinburgh: E. & S. Livingstone. 21s. net.

" They shall not grow old, as we that are left grow old :
Age shall not weary them, nor the years condemn.
At the going down of the sun, and in the morning we will remember them."—*Laurence Binyon.*

THIS book is dedicated to the author's only child—his son—who was accidentally killed on July 29, 1943, aged 15. How many parents have suffered thus during the past six years? The sympathy of all must go out to those who have experienced such a calamity. They can only bow and accept the decrees of Providence and try to realize that " the trivial round, the common task, would furnish all we ought to ask "—but *so* it is, and in this *his* latest book for those who do not grow old—namely, the students—he has accepted the decree and applied himself to the endless and perpetual task of the teacher.

He vindicates the book when he says, " My critics say that I expect my nurses to know too much. I contend that if nurses understand the principles upon which this operation (and others) are founded not only will their work be interesting, but they are bound to become more skilful." Few surgeons will disagree with this. All know full well the difference between the haphazard assistance in theatre or elsewhere of the nurse who is content to remain merely a cipher and the one who, though perhaps only preparing for a manipulation, or handing an instrument, is doing each step of such procedure in her own mind. In the latter case all runs smoothly, while in the former preventable difficulties arise which may ultimately lead to chaos.

The book consists of eighty-three demonstrations of surgical procedures ; the consecutive steps of each and the *raison d'être* are explained in simple language helped with beautiful illustrations. For the more specialized operations the author has availed himself of the help of twenty-four contributors, including three theatre sisters and a surgical instrument maker.

The style of the book remains conversational throughout and leaves in the mind of the reader the impression of an absence of hurry and fuss in the theatre, and a realization that the only thing that matters is the well-being of the patient.

Interest is also maintained by the brief footnotes on almost every page, which give the period during which he lived, and the place where he worked, of every surgeon mentioned in connexion with an instrument, operation, or manœuvre. If these footnotes are studied it will prevent ideas such as *that Rokitansky was one of Napoleon's cavalry generals.*

It is, however, a pity that the photograph which is the frontispiece and is also on the book jacket should have been included. It is a copy of a photograph called " Women in White ", or it might be "How Not to Wear a Mask ", by a leading American surgeon. It creates a bad impression, as in four out of the six women depicted, the face mask is not over the nostrils. It is to be hoped that this is merely due to hustle and has now been rectified in the University of Chicago. The first demonstration is rightly that on the basic instruments used, with a description of how and when they are usually employed. This is followed by one on the management of the operating table ; one almost wishes that this had been printed in heavy type. Demonstrations in natural sequence follow on the management of the theatre sterilizers and theatre lamp, on the care and sterilization of rubber gloves, syringes, scissors and scalpels, drainage tubes, etc.

The ritual of preparation of the surgeon for the operation follows next (there is a slight mistake in the caption below *Fig.* 66). Then the method of administering intravenous fluids is discussed—a procedure in which the nurse can play such a helpful or devastating part.

Abdominal surgery is introduced by a demonstration on the anatomy of the abdominal wall and the various incisions which can be used for a laparotomy. After this the common operations done in any large general hospital are discussed and described. The author emphasizes " that the operations I demonstrate to you show only the method I employ ", and how much better it is to know one method well than odds and ends of several. Suffice it to say that any nurse who has experienced and studied these demonstrations could always easily appreciate the variations employed in the individual technique of any operator. The book will be of the greatest value not only to nurses both during and after their period of training, but should also be studied by every medical student, and kept for reference while a house surgeon and later.

Many will criticize that much in the book is quite unnecessary for a nurse to know—" theirs not to reason why "—or they may say that the nurse should comfort herself with such thoughts as " they also serve who only stand and wait ". This attitude is surely wrong, as is quoted in the Preface from a lecture by Evarts A. Graham, when President of the American College of Surgeons : " The fact that Florence Nightingale and Joseph Lister were contemporaries has been of the greatest importance to us ". The converse is also true, how much better doctors we might be if some things were excised from the curriculum and replaced by six months in the wards as a nursing orderly, with a course of lectures and demonstrations by a good Sister tutor.

Lecture demonstrations such as these can only do good and must contribute to the realization of the medical ideal—" There shall be no more death, neither sorrow nor crying, neither shall there be any more pain" .

Anatomical Atlas of Orthopædic Operations. By L. S. MICHAELIS, M.D., Orthopædic Surgeon, E.M.S. ; Member of the Orthopædic Unit, Botleys Park War Hospital. $9\frac{3}{4} \times 7\frac{3}{8}$ in. Pp. 67, with 73 illustrations in colour. 1946. London : William Heinemann (Medical Books) Ltd. 25s. net.

THIS book is a guide chiefly to the approaches used in operative procedures on the locomotor system, but stops short of the later stages. The less experienced surgeon, for whom this book was presumably written, will thus require to refer to a fuller account.

The many illustrations are so over simplified that much which would have been of value has been omitted. The author has added little to the descriptions of operations in works readily available.

Sciatiques et Lombalgies par Hernie postérieure des Disques intervertébraux. By D. PETIT-DUTAILLIS, Professeur de Pathologie chirurgicale à la Faculté de Médecine ; Chirurgien de l'Hôpital Bichat, and S. DE SÈZE, Médecin des Hôpitaux de Paris. $9\frac{5}{8} \times 6\frac{5}{8}$ in. Pp. 180, with 133 illustrations. 1945. Paris : Masson et Cie. Fr. 235.

Choc traumatique. Étude clinique, physio-pathologique et thérapeutique. By J. CREYSSEL, Professeur Agrégé à la Faculté de Lyon ; and P. SUIRE, Ex-Chef de Clinique Chirurgicale à la Faculté de Paris. With a Preface by Professor R. LERICHE. 10 × $6\frac{1}{2}$ in. Pp. 310. 1944. Paris : Masson et Cie. Fr. 160.

Hypoglycémies spontanées. Le Traitement chirurgical de l'Hyperinsulinisme. By P. MALLET-GUY, Professeur Agrégé à la Faculté de Médecine de Lyon, and P. MAILLET, Prosecteur à la Faculté de Médecine de Lyon. With a Preface by Professor H. MONDOR. $7\frac{3}{4} \times 5\frac{3}{8}$ in. Pp. 102, with 17 illustrations. 1944. Paris : Masson et Cie. Fr. 55.

THREE recent publications from the House of Masson et Cie, Paris, and it is interesting to note that this well-known French publishing firm is once again in active production.

The first title is a useful work well documented and

illustrated. It begins with a very clear study of the anatomy and pathology of the condition. Later chapters include diagnosis, clinical conditions, and treatment.

In *Choc Traumatique* two surgeons have put out their observations, experiences, reflections, and researches on the subject. In a Preface Professor Leriche commends these two workers and their conclusions. Like most similar works, this book is difficult to understand and the problem remains unsolved.

Synopsis of the Diagnosis of the Surgical Diseases of the Abdomen. By JOHN A. HARDY, B.Sc., M.D., F.A.C.S., El Paso, Texas. Second edition. 7⅝ × 4⅞ in. Pp. 528, with 100 illustrations. 1945. London: Henry Kimpton. 25s. net.

THE second edition of this pocket synopsis of surgical diseases of the abdomen has been carefully revised and brought up to date. It is pleasing to see that one's surgical friends in America are keen in inculcating a clinical atmosphere in the diagnosis of abdominal conditions and not relying entirely on special laboratory reports or X-ray films.

This book advocates painstaking examination of the patient and many useful pictures and diagrams illustrate the best methods of clinical examination.

Students and post-graduates will find this a useful pocket book, which is full of sound, practical advice.

BOOK NOTICES

[*The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.*]

A Complete Outline of Fractures, including Fractures of the Skull. By J. GRANT BONNIN, M.B., B.S. (Melbourne), F.R.C.S. (Eng.). Second edition. 8⅝ × 5⅝ in. Pp. 658 + xiv, with 712 illustrations. 1946. London: William Heinemann (Medical Books) Ltd. 30s. net.

Injuries of the Knee Joint. By I. S. SMILLIE, O.B.E., M.B., F.R.C.S. (Edin.), F.R.F.P.S., Surgeon-in-Charge, Orthopædic Hoapital, Larbert, Stirlingshire (Scottish E.M.S.). 9⅝ × 6⅞ in. Pp. 320 + xi, with 350 illustrations. 1946. Edinburgh: E. & S. Livingstone Ltd. 35s. net.

Synopsis of Genitourinary Diseases. By AUSTIN I. DODSON, M.D., F.A.C.S., Richmond, Va. Fourth edition. 7⅝ × 4⅞ in. Pp. 313, with 112 illustrations. 1945. London: Henry Kimpton. 18s. net.

Regional Analgesia. By H. W. L. MOLESWORTH, F.R.C.S. (Eng.), Senior Surgeon, Royal Victoria Hospital, Folkestone. Second edition. 8⅝ × 5 in. Pp. 92 + viii, with 42 illustrations. 1946. London: H. K. Lewis & Co. Ltd. 8s. 6d. net.

The Surgical Clinics of North America. Chicago Number, February, 1946. Symposium on Surgical Technic. 9 × 6 in. Pp. 269 + vi, with 172 illustrations. London and Philadelphia: W. B. Saunders Co. Annual subscription (six numbers), paper 55s.; cloth 75s.

The Surgical Technic of Abdominal Operations. By JULIUS L. SPIVACK, M.D., LL.D., Associate Professor of Surgery, University of Illinois College of Medicine. Fourth edition. 9⅞ × 6⅝ in. Pp. 709 × xvi, with 362 illustrations. 1946. Springfield, Ill.: Charles C. Thomas. $10.00.

The Surgical Clinics of North America. New York Number, April, 1946. Symposium on Surgical Diagnosis. 9 × 6 in. Pp. 253 + viii, with 72 illustrations. London and Philadelphia: W. B, Saunders Co. Annual subscription (six numbers). paper 55s.; cloth 75s.

Occupational Therapy for the Limbless. By PHYLLIS LITTLETON, C.S.P., M.A.O.T., Late Occupational Therapist, Ministry of Pensions Hospital, Leeds. Drawings by JOAN HARRY. 7¼ × 4⅞ in. Pp. 40 + viii, with 12 illustrations. 1946. London: H. K. Lewis & Co. Ltd. 3s. net.

Diagnóstico y Tratamiento de las Varices Esenciales. By J. VALLS-SERRA, Barcelona. 8½ × 5⅞ in. Pp. 189, with 32 illustrations, mostly plates. 1945. Barcelona: Editorial "Rubí". Pesetas 35.

The Causation of Appendicitis. By A. RENDLE SHORT, M.D., B.S., B.Sc., F.R.C.S., Professor of Surgery, University of Bristol; Surgeon, Bristol Royal Infirmary. 7¼ × 4⅞ in. Pp. 79 + viii, with 4 charts. 1946. Bristol: John Wright & Sons Ltd. 10s. net.

The Technical Minutiæ of Extended Myomectomy and Ovarian Cystectomy. By VICTOR BONNEY, M.S., M.D., B.Sc. (Lond.), F.R.C.S. (Eng.), Hon. F.R.A.C.S., M.R.C.P. (Lond.). 9¾ × 6½ in. Pp. 282 + vi, with 242 original drawings by the Author. 1946. London: Cassell & Co. Ltd. 30s. net.

The Care of the Neurosurgical Patient. Before, During, and After Operation. By ERNEST SACHS, A. B., M.D., Professor of Clinical Neurological Surgery, Washington University School of Medicine, Saint Louis. 9½ × 6½ in. Pp. 268, with 177 illustrations. 1945. London: Henry Kimpton. 30s. net.

The Results of Radium and X-ray Therapy in Malignant Disease. Being the Second Statistical Report from the Holt Radium Institute, Manchester. Years 1934–1938, inclusive, assessed at 5 years, and 1932 and 1933 assessed at 10 years. Compiled by RALSTON PATERSON, MARGARET TOD, and MARION RUSSELL. 1946. Edinburgh: E. & S. Livingstone Ltd. 7s. 6d. net.

La Méthode du Lever précoce en Chirurgie abdominale. Prophylaxie des Phlébites et Embolies post-opératoires. By ANDRÉ CHALIRE, Professeur agrégé à la Faculté de Médicine de Lyon. 7¾ × 5¼ in. Pp. 112. 1945. Paris: Masson et Cie. Fr. 70.

Demonstrations of Physical Signs in Clinical Surgery. By HAMILTON BAILEY, F.R.C.S. (Eng.), F.I.C.S., Surgeon, Royal Northern Hospital. Tenth edition, revised. 8¾ × 5⅝ in. Pp. 375 + xii, with 573 illustrations, a number of which are in colour. 1946. Bristol: John Wright & Sons Ltd. 30s. net.

Essentials of Urinary and Genital Diseases. By SAM I. HADDAD, M.D., F.A.C.S., Professor of Surgery, School of Medicine, American University of Beirut, Lebanon. 9⅜ × 6⅝ in. Pp. 207 + x, with 55 illustrations. 1946. Beirut: American Press. 50s.

The Anatomy of the Bronchial Tree. With Special Reference to the Surgery of Lung Abscess. By R. C. BROCK, M.S. (Lond.), F.R.C.S. (Eng.), Surgeon to Guy's Hospital; Surgeon to the Brompton Hospital; Surgeon to an E.M.S. Thoracic Surgical Centre. 9⅜ × 6 in. Pp. 96 + vi, with 142 illustrations, many as plates. 1946. London: Geoffrey Cumberlege, Oxford University Press. 42s. net.